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ABSTRACT

This module is the eighth of nine modules in the competency-based Missouri Auto Mechanics Curriculum Guide. Six units cover: introduction to automatic transmission/transaxle; hydraulic control systems; transmission/transaxle diagnosis; automatic transmission/transaxle maintenance and adjustment; in-vehicle transmission repair; and off-car transmission repair. Introductory materials include a competency profile and cross-reference table that shows how competencies relate to instructional objectives, job sheets, assignment sheets, and test items. Each unit consists of some or all of these components: objective sheet with unit and specific objectives; cover sheet with content outline and list of references; information sheets; assignment sheets; job sheets; and unit test with answer key. (YLB)

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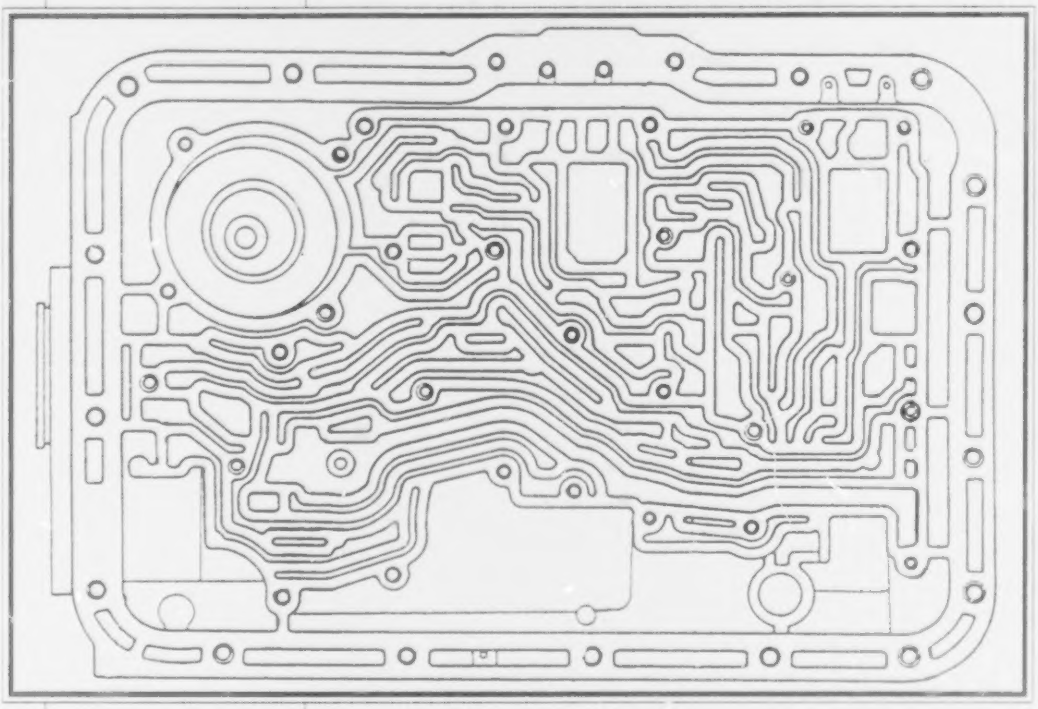
70-1808-I
Instructor's Guide

Auto Mechanics
Curriculum Guide



Module 8

Automatic Transmissions And Transaxles

Produced by
Instructional Materials Laboratory
In cooperation with the Dept. of
Elementary and Secondary
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MODULES INCLUDED IN THE AUTO MECHANICS CURRICULUM GUIDE

INTRODUCTION TO AUTO MECHANICS
ELECTRICAL SYSTEMS
ENGINE PERFORMANCE
ENGINE REPAIR
SUSPENSION AND STEERING
BRAKES
MANUAL DRIVE TRAIN AND AXLES
AUTOMATIC TRANSMISSION AND TRANSAXLES
HEATING AND AIR CONDITIONING

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AUTO MECHANICS CURRICULUM

MODULE 8: AUTOMATIC TRANSMISSION/TRANSAXLE

INSTRUCTOR'S GUIDE

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FOREWORD

Once again, we are indebted to the teachers and administrators who provide their time, efforts, and professionalism to develop curriculum for trade, technical, and industrial education programs. The Automatic Transmission/Transaxle module (the eighth of nine modules to make up the Missouri Auto Mechanics Curriculum Guide) is an outstanding example of what can be accomplished when the right people with the right attitude work together. The curriculum writers and subject matter experts who worked on this guide are to be commended for a job well done.

The module's format has been developed for competency-based teaching and testing. Job sheets within the guide evaluate specific competencies and can be managed with the Vocational Administrative Management System (VAMS). All major components of the module have been keyed to the Missouri Auto Mechanics Competency Profile, which was developed by industry and education professionals within Missouri.

Special appreciation is given to David Hevel, the module's writer. Special appreciation is also given to Fred Smith, who served as a technical adviser during production of the module.

The format and curriculum management system found in this module may be new to many vocational educators. However, we are confident that, when used as designed, this module will allow for a more productive and rewarding educational experience for both teacher and student. Any future auto mechanics curriculum modifications will begin with the Missouri Auto Mechanics Curriculum Guide. Auto mechanics, like many technical fields, is undergoing constant and considerable change. We will annually evaluate the need to update this guide on a module-by-module basis. Your suggestions regarding areas for improvement are both encouraged and appreciated.

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Department of Elementary and Secondary Education

Charles Waibel, Director
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ACKNOWLEDGEMENTS

Automatic Transmission/Transaxle is the eighth of nine modules that make up the Missouri Auto Mechanics Curriculum Guide. Produced by the Instructional Materials Laboratory (IML), the guide represents a continuing commitment to Missouri's Vocational Instructional Management System (VIMS). All modules in the guide are based on the Missouri Auto Mechanics Competency Profile, which in turn is based on and cross-referenced to the ASE task list. For years ASE has set the professional standards for automotive technicians. Therefore, a strong ASE orientation makes the guide an effective tool for preparing students to enter the technologically advanced field of auto mechanics.

IML extends special recognition to David Hevel, the writer of Automatic Transmission/Transaxle. Mr. Hevel's years of experience as both a teacher and an automotive technician is evident throughout his work. Special recognition also goes to Fred Smith, who contributed heavily to the module as a technical adviser. Mr. Smith's attention to technical detail proved invaluable throughout the module's development.

IML gratefully acknowledges the important contribution of the advisory committee, which, among other tasks, developed the competency profile for the guide. The advisory committee members are listed below:

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Charles Waibel and Judith Moore, Division of Vocational and Adult Education, Department of Elementary and Secondary Education, Jefferson City, Mo.
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Darwin Kraenow, Linn Technical College, Linn, Mo.

IML also acknowledges the fieldtesters, who worked to ensure that the Automatic Transmission/Transaxle module was developed into an effective and practical teaching tool. The fieldtesters are listed below:

Fieldtesters

Robert Barbarick, Four Rivers AVTS, Washington, Mo.
Robert Colesworthy, Lewis & Clark AVTS, St. Charles, Mo.
Don Corbin, North Central AVTS, Bethany, Mo.
Richard Diklich, Longview Community College, Lee's Summit, Mo.
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Robin Ferguson, Kirksville AVTS, Kirksville, Mo.
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IML would like to express special appreciation to Auffenberg's Eldon Ford-Mercury in Eldon, Mo. and to Joe Machens Ford in Columbia Mo. for providing access to their technical libraries.

The support and contributions of the following IML staff members were instrumental to the development of this module:

Instructional Materials Laboratory Staff

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Phyllis Miller, Assistant Director
Dan Stapleton, Assistant Director
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UNIT IV: AUTOMATIC TRANSMISSION/TRANSAXLE MAINTENANCE AND ADJUSTMENT .... ATT 141

UNIT V: IN-VEHICLE TRANSMISSION REPAIR .... ATT 181

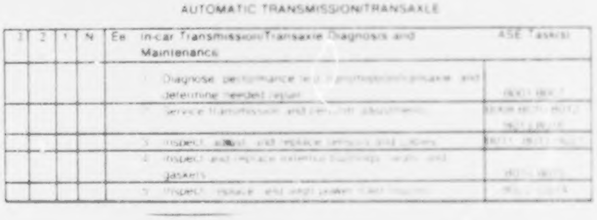
UNIT VI: OFF-CAR TRANSMISSION REPAIR .... ATT 263

HOW TO USE THE MISSOURI AUTO MECHANICS CURRICULUM GUIDE

Every module of the Missouri Auto Mechanics Curriculum Guide contains the following seven major components: (1) a competency profile, (2) objective sheets, (3) information sheets, (4) assignment sheets, (5) job sheets, (6) tests, and (7) a cross-reference table. Below is a discussion of the design of these components.

MISSOURI COMPETENCY PROFILE

The competency profile identifies 144 basic auto mechanics competencies. The profile divides the competencies into nine general areas, each of which serves as the basis for individual modules of instruction (such as the Automatic Transmission/Transaxle module). The competency profile further divides these general areas into duty bands, each of which is identified by a capital letter. An example of a duty band in the Automatic Transmission/Transaxle module would be "In-car Transmission/Transaxle Diagnosis and Maintenance." Under each duty band are listed several competencies, each of which is identified by an Arabic numeral. Note the below excerpt from the competency profile:



AUTOMATIC TRANSMISSION/TRANSAXLE

3	2	1	N	Ee In-car Transmission/Transaxle Diagnosis and Maintenance	ASE Task(s)
				1. Diagnose, performance test transmission/transaxle, and determine needed repair	[illegible]
				2. Service transmission and perform adjustments	[illegible]
				3. Inspect, adjust, and replace sensors and cables	[illegible]
				4. Inspect and replace external bushings, seals, and gaskets	[illegible]
				5. Inspect, replace, and [illegible]	[illegible]

In this excerpt, the duty band "In-car Transmission/Transaxle Diagnosis and Maintenance" is identified by the letters "Ee." The competency "Service transmission and perform adjustments" falls under Duty Band Ee and is identified by the Arabic numeral "2." Throughout the Automatic Transmission/Transaxle module, therefore, the competency "Service transmission and perform adjustments" will be referred to as Competency Ee2. Other competencies under Duty Band Ee are, for example, Ee1, "Diagnose, performance test transmission/transaxle, and determine needed repair," and Ee3 "Inspect, adjust, and replace sensors and cables."

Also note that one or more ASE tasks are listed to the right side of each competency on the profile. These ASE tasks are directly related to those competencies by which the tasks appear.

(**NOTE**: The term "cross-reference table" will appear throughout the rest of this discussion. A cross-reference table is a chart that shows precisely how objectives, assignment sheets, test questions, and job sheets are related to individual competencies. The cross-reference table will be discussed later in more detail.)

INFORMATION SHEETS

The information sheets (or information outline) present the student with important facts and concepts relating to basic automotive technology and service procedures. The information sheets also explain why a procedure is necessary and why it must be performed in a certain manner. Though not intended to be as comprehensive as a textbook, the information sheets provide a good source of information to which the student can refer outside of class. Perhaps the information sheets can best be thought of as a thorough set of notes accompanying the instructor's classroom lecture.

ASSIGNMENT SHEETS

The assignment sheets serve one of two functions: they can either emphasize important cognitive information or instruct students in developing procedures specific to a particular vehicle. The "Notes to the Instructor," found on the table of contents section of each module, indicates how each assignment sheet is used.

(**NOTE:** Assignment sheets are not used to evaluate competencies directly. Only job sheets directly evaluate competencies.)

UNIT TESTS

Unit tests cover information relating to specific competencies. The student must obtain acceptable test scores (decided upon by the instructor) before receiving an evaluation for these competencies. (Since job sheets are used to evaluate competencies, the student, therefore, must receive an acceptable test score before doing certain job sheets.) The test ensures that the student has the minimum knowledge required to perform the competencies covered on the job sheets. On most tests, one group of questions covers information related exclusively to one competency or group of competencies while another group of questions relates exclusively to another competency or group of competencies. Questions relating to a specific competency or group of competencies are divided into parts. At the end of each part, a note like the following appears:

> (NOTE: The student must obtain a minimum score of _____ on Part III of the Unit V Test in order to receive an evaluation for Competency Ee3.)

(NOTE: The Unit I Test and Unit II Test involve basic principles and theory relating to the automatic transmission. These tests are accompanied by notes stating that the student must obtain acceptable scores before performing any competencies in the module.)

All the test questions and job sheets related to each competency are listed on the module's cross-reference table. The cross-reference table allows the instructor to determine what test questions a student must successfully complete before being eligible to perform the job sheets related to a particular competency. By observing the test notes and using the cross-reference table, the instructor can easily determine what job sheets a student is eligible to do as a result of his or her score on a particular part of a test.

OBJECTIVE SHEETS

The first page of each unit in the guide is an objective sheet, which states the unit's general and specific objectives. Below is a partial reproduction of the objective sheet for Unit IV of the Automatic Transmission/Transaxle module:

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

UNIT IV: AUTOMATIC TRANSMISSION/TRANSAXLE MAINTENANCE AND ADJUSTMENT

UNIT OBJECTIVE

After completing this unit, the student should be able to service and make external adjustments on automatic transmissions/transaxles. The student will demonstrate mastery of the material by achieving a score of ____ on the unit test and successfully performing specific tasks.

SPECIFIC OBJECTIVES

After completing the lesson in this unit, the student should be able to:

Lesson 1.

I. Identify terms and definitions associated with the maintenance and adjustment of automatic transmissions (Competency Ee2, Part I of the Unit IV Test)

II. Identify the procedures for changing fluid and filter in an automatic transmission (Competency Ee2, Part I of the Unit IV Test).

III. Identify the procedures for adjusting the manual and throttle valve linkage or the cable in an automatic transmission (Competency Ee2, Part I of the Unit IV Test).

IV. Identify the operating principles of and the maintenance procedures for bands within automatic transmissions (Competency Ee2, Part I of the Unit IV Test).

V. Identify the operating principles of and the maintenance procedures for automatic transmission sensors (Competency Ee3, Part II of the Unit IV Test).

VI. Demonstrate the ability to:

    a. Service fluid and filter in an automatic transmission (Competency Ee2, JS1-L1-UIV).

    b. Adjust the manual and throttle valve in an automatic transmission (Competency Ee2, JS2-L1-UIV).

ASE TASKS COVERED IN THIS UNIT

I. The job sheets in this unit cover ASE tasks B008-B011 and B021.

Notice that the specific objectives are designated by Roman numerals. Also notice that the competency (or competencies) to which each objective relates is listed in parentheses behind each objective. Also listed in parentheses is the method by which the student's ability to perform the objective is evaluated.

A note identifying the ASE tasks that are covered by the unit's job sheets appears at the end of every objective sheet.

JOB SHEETS

Besides giving the student practical, hands-on experience in auto mechanics, job sheets provide a means of evaluating a student's ability to perform the competencies. The job sheets are, therefore, the key component of the Missouri Auto Mechanics Curriculum Guide. Below is an excerpt from the first page of a typical job sheet in the Automatic Transmission/Transaxle module:

JS1-L1-UIV

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

SERVICING FLUID AND FILTER IN AN AUTOMATIC TRANSMISSION

Equipment:

Hoist or jacks and jack stands
Drain pan
Safety glasses

Procedure:

		Evaluation 3 2 1 N
1.	Wear safety glasses while doing all procedures on this job sheet.	_ _ _ _
2.	Complete AS2-L1-UIV. Following the procedure developed in item 2 of AS2-L1-UIV, service the vehicle's automatic transmission fluid and filter. Also inspect the condition of the fluid and the fluid deposits in the pan. Record observations.	_ _ _ _

Notice that the job sheet is identified as JS1-L1-UIV, which translates into Job Sheet 1, Lesson 1, Unit IV. This shorthand system of job sheet identification is used throughout the curriculum guide.

(**NOTE:** Assignment sheets are identified with the same shorthand system. Assignment Sheet 1, Lesson 1, Unit III would be AS1-L1-UIII.)

(**NOTE:** Both job sheets and assignment sheets are numbered consecutively within unit lessons.)

Also notice that, in the above job sheet excerpt, the spaces to the right of the page allow the instructor to evaluate the student on a particular job sheet activity. These spaces appear only by numbered items, which represent significant tasks; therefore, the instructor is freed from having to evaluate the minor steps of a procedure. At the beginning of each job sheet, the heading "3 2 1 N" indicates the four possible evaluations a student can receive. The meaning of the numbers and the letter N is as follows:

3 = **Mastery** - can work independently with no supervision
2 = **Requires Supervision** - can perform job completely with limited supervision
1 = **Not Mastered** - requires instruction and close supervision
N = **No Exposure** - no experience or knowledge in this area

The individual evaluations made throughout a job sheet are averaged together at the end of the job sheet. A note at the end of the job sheet explains how this average relates to the final evaluation for a particular competency. Shown below is a note found at the end of a job sheet JS9-L1-UVI. The note explains that the average of the individual evaluations made throughout the job sheet is the final evaluation for Competency Ff3.

Average of above evaluations* ____

(This average is a partial evaluation for Competency Ff1. Final evaluation for Ff1 will be made at the end of JS5-L2-UVI.)

As automotive instructors know, an automobile contains many complex and interrelated components. A single general service task may involve several different procedures. In the Missouri Auto Mechanics Curriculum Guide, therefore, a competency may be evaluated over several job sheets; also one job sheet may evaluate several competencies. As will be demonstrated later, each job sheet is accompanied by a thorough set of instructions, explaining how each of the final job sheet averages is to be used. The cross-reference table is also quite helpful in showing which job sheets evaluate which competencies.

CROSS-REFERENCE TABLE

The cross-reference table can quickly reveal [illegible]mpetencies relate to instructional objectives, job sheets, and test items. Note the following excerp[illegible] the Automatic Transmission/Transaxle module cross-reference table:

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE
CROSS-REFERENCE TABLE OF INSTRUCTIONAL MATERIALS

Competency	Instructional Objective	Assignment Sheet	Job Sheet	Test Item	Notes
Ee2	UI-L1-I, UI-L1-II, UI-L2-I, UI-L2-II, UI-L2-III, UII-L1-I, UII-L1-II, UII-L1-III, UII-L1-IV, UII-L2-I, UII-L2-II, UII-L3-I, UII-L3-II, UII-L3-III, UII-L4-I, UII-L4-II, UII-L4-III, UIV-L1-I, UIV-L1-II, UIV-L1-III, UIV-L1-IV, UV-L1-II, UV-L2-I	AS1-L1-UII AS1-L2-UII AS1-L4-UII AS1-L1-UIV AS2-L1-UIV AS3-L1-UIV AS4-L1-UIV AS1-L1-UV AS2-L1-UV AS3-L1-UV AS1-L2-UV AS2-L2-UV AS3-L2-UV	JS1-L1-UIV JS2-L1-UIV JS3-L1-UIV JS1-L1-UV JS2-L1-UV JS1-L2-V JS2-L2-V	UI 1-28 UII 1-38 UIV 1-24 UV 6-20	

Note that the excerpt from the cross-reference table lists all the instructional objectives in the module that cover Competency Ee2. The cross-reference table also indicates the test questions that cover Competency Ee2. Just as importantly, the table reveals at a glance that the student must perform JS1-L1-UIV, JS2-L1-UIV, JS3-L1-UIV, JS1-L1-UV, JS2-L1-UV, JS1-L2-UV, and JS2-L2-UV before he or she can receive an evaluation for Competency Ee2. By looking at the cross-reference table, the instructor can, therefore, quickly determine what test questions a student needs to answer and what job sheets a student needs to perform before receiving a final evaluation for a particular competency.

HOW AND WHY COMPETENCIES ARE EVALUATED OVER SEVERAL JOB SHEETS

According to the competency profile, Competency Ee2 "Inspect, adjust, and replace sensors and cables" covers 6 major ASE tasks. A job sheet covering all six of these ASE tasks would be unreasonably long and overly complicated. As was indicated above, the Missouri Auto Mechanics Curriculum Guide allows the student to perform several job sheets in order to receive an evaluation for Competency Ee2. These job sheets are listed below:

JS1-L1-UIV: Servicing Fluid and Filter in an Automatic Transmission
JS2-L1-UIV: Adjusting the Manual and Throttle Valve in an Automatic Transmission
JS3-L1-UIV: Adjusting the Bands in an Automatic Transmission
JS1-L1-UV: Testing and Adjusting the Vacuum Modulator
JS2-L1-UV: Inspecting and Testing the Governor and Governor Cover
JS1-L2-UV: Testing and Flushing Transmission Coolers
JS2-L2-UV: Repairing Transmission Cooler Lines

The activities in the above job sheets satisfy Missouri Competency Ee2 and the ASE tasks that accompany Ee2. At the end of each job sheet relating to Ee2, a note explains that the individual evaluations made throughout the job sheet are averaged together to determine a partial evaluation for Ee2. The note also indicates on what job sheet the final evaluation for Ee2 will be determined. Below is an example of the note found at the end of JS1-L1-UIV:

Average of above evaluations* — — — —

(*This average is a partial evaluation for Competency Ee2. Final evaluation for Ee2 will be made at the end of JS2-L2-UV.)

At the end of JS2-L2-UV, the following note is found:

Average of above evaluations* — — — —

(*This average is a partial evaluation for Competency Ee2. Final evaluation for Ee2 will be made at the end of this job sheet.)

Also at the end of JS2-L2-UV, the following instructions explain how the final evaluation for Ee2 is to be made:

FINAL EVALUATION INSTRUCTIONS

1. Determine the student's final evaluation for Competency Ee2 by averaging the evaluations of JS1-L1-UIV, JS2-L1-UIV, JS3-L1-UIV, JS1-L1-UV, JS2-L1-UV, JS1-L2-UV, and JS2-L2-UV. Use the spaces provided below.

	Evaluation 3	 2	 1	 N
JS1-L1-UIV	___	___	___	___
JS2-L1-UIV	___	___	___	___
JS3-L1-UIV	___	___	___	___
JS1-L1-UV	___	___	___	___
JS2-L1-UV	___	___	___	___
JS1-L2-UV	___	___	___	___
JS2-L2-UV	___	___	___	___
Final evaluation for Competency Ee2	___	___	___	___

The content of the Automatic Transmission/Transaxle module is organized in the most teachable manner possible; therefore, content relating to Competency Ee2 is covered in both Unit IV and Unit V. The job sheets evaluating Ee2, therefore, appear in all two of these units rather than being grouped together. Again, the job sheet notes and the cross-reference table make it easy to identify and assign the job sheets that relate to a specific competency.

Job sheet notes sometimes vary to reflect the content of the job sheet. The information in the note, however, is always presented in a straight-forward, easy-to-understand manner.

PACKAGING OF THE AUTO MECHANICS CURRICULUM GUIDE

Each module in the Auto Mechanics Curriculum Guide is packaged in three components: an instructor's guide, a student reference, and student work sheets. The instructor's guide includes the following items, all of which are color coded:

Cross-reference table (color-coded white)
Objective sheets (color-coded white)
Table of contents, references, notes to the instructor, answer sheets for assignment sheets and tests (color-coded pink)
Information sheets (color-coded green)
Assignment sheets (color-coded tan)
Job sheets (color-coded blue)
Unit tests (color-coded yellow)

The student reference contains copies of the objective sheets and information sheets from the instructor's guide. The student work sheets include consumable items from the instructor's guide, such as job sheets, assignment sheets, and unit tests. For convenience, the page numbers of the items in the student reference and in the work sheets are the same as those in the instructor's guide; therefore, page numbers in the student reference and work sheets are not consecutive. All student reference pages and work sheet pages are white.

Competency profiles for the guide are packaged in groups of ten along with a copy of the ASE task list.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE
CROSS-REFERENCE TABLE OF INSTRUCTIONAL MATERIALS

Competency	Instructional Objective	Assignment Sheet	Job Sheet	Test Item	Notes
Ee1	UI-L1-I, UI-L1-II, UI-L2-I, UI-L2-II, UI-L2-III, UII-L1-I,UII-L1-II, UII-L1-III, UII-L1-IV, UII-L2-I, UII-L2-II, UII-L3-I, UII-L3-II, UII-L3-III, UII-L4-I, UII-L4-II, UII-L4-III, UIII-L1-I, UIII-L1-II, UIII-L1-III, UIII-L1-IV, UIII-L1-V, UIII-L2-I, UIII-L2-II, UIII-L2-III, UIII-L2-IV, UIII-L2-V, UIII-L2-VI, UV-L1-I	AS1-L1-UII AS1-L2-UII AS1-L4-UIII AS1-L1-UIII AS2-L1-UIII AS1-L2-UIII AS2-L2-UIII	JS1-L1-UIII JS2-L1-UIII JS3-L1-UIII JS1-L2-UIII JS2-L2-UIII JS3-L2-UIII	UI 1-28 UII 1-38 UIII 1-34 UV 1-5	
Ee2	UI-L1-I, UI-L1-II, UI-L2-I, UI-L2-II, UI-L2-III, UII-L1-I, UII-L1-II, UII-L1-III, UII-L1-IV, UII-L2-I, UII-L2-II, UII-L3-I, UII-L3-II, UII-L3-III, UII-L4-I, UII-L4-II, UII-L4-III, UIV-L1-I, UIV-L1-II, UIV-L1-III, UIV-L1-IV, UV-L1-II, UV-L2-I	AS1-L1-UII AS1-L2-UII AS1-L4-UII AS1-L1-UIV AS2-L1-UIV AS3-L1-UIV AS4-L1-UIV AS1-L1-UV AS2-L1-UV AS3-L1-UV AS1-L2-UV AS2-L2-UV AS3-L2-UV	JS1-L1-UIV JS2-L1-UIV JS3-L1-UIV JS1-L1-UV JS2-L1-UV JS1-L2-V JS2-L2-V	UI 1-28 UII 1-38 UIV 1-24 UV 6-20	
Ee3	UI-L1-I, UI-L1-II, UI-L2-I, UI-L2-II, UI-L2-III, UII-L1-I, UII-L1-II, UII-L1-III, UII-L1-IV, UII-L2-I, UII-L2-II, UII-L3-I, UII-L3-II, UII-L3-III, UII-L4-I, UII-L4-II, UII-L4-III, UIV-L1-V, UV-L1-II, UV-L2-I	AS1-L1-UII AS1-L2-UII AS1-L4-UII AS5-L1-UIV AS4-L2-UV	JS4-L1-UIV JS5-L1-UV JS3-L2-UV	UII 1-38 UIV 25-30 UV 21-30	
Ee4	UI-L1-I, UI-L1-II, UI-L2-I, UI-L2-II, UI-L2-III, UII-L1-I, UII-L1-II, UII-L1-III, UII-L1-IV, UII-L2-I, UII-L2-II, UII-L3-I, UII-L3-II, UII-L3-III, UII-L4-I, UII-L4-II, UII-L4-III, UIV-1-II	AS4-L1-UV AS1-L1-UII AS1-L2-UII AS1-L4-UII	JS3-L1-UV JS4-L1-UV	UI 1-28 UII 1-38 UV 31-40	

Competency	Instructional Objective	Assignment Sheet	Job Sheet	Test Item	Notes
Ee5	UI-L1-I, UI-L1-II, UI-L2-I, UI-L2-II, UI-L2-III, UII-L1-I, UII-L1-II, UII-L1-III, UII-L1-IV, UII-L2-I, UII-L2-II, UII-L3-I, UII-L3-II, UII-L3-III, UII-L4-I, UII-L4-II, UII-L4-III, UV-L2-I	AS1-L1-UII AS1-L2-UII AS1-L4-UII AS5-L2-UV	JS4-L2-UV	UI 1-28 UII 1-38 UV 41-50	
Ff1	UI-L1-I, UI-L1-II, UI-L2-I, UI-L2-II, UI-L2-III, UII-L1-I, UII-L1-II, UII-L1-III, UII-L1-IV, UII-L2-I, UII-L2-II, UII-L3-I, UII-L3-II, UII-L3-III, UII-L4-I, UII-L4-II, UII-L4-III, UVI-L1-I, UVI-L1-II, UVI-L1-III, UVI-L1-V, UVI-L1-VI, UVI-L1-XI, UVI-L2-II, UVI-L2-IV	AS1-L1-UII AS1-L2-UII AS1-L4-UII AS1-L1-UVI AS2-L1-UVI AS3-L1-UVI AS4-L1-UVI AS4-L2-UVI AS5-L2-UVI	JS1-L1-UVI JS2-L1-UVI JS3-L1-UVI JS4-L1-UVI JS5-L1-UVI JS6-L1-UVI JS4-L2-UVI JS5-L2-UVI	UI 1-28 UII 1-38 UVI 1-10	
Ff2	UI-L1-I, UI-L1-II, UI-L2-I, UI-L2-II, UI-L2-III, UII-L1-I, UII-L1-II, UII-L1-III, UII-L1-IV, UII-L2-I, UII-L2-II, UII-L3-I, UII-L3-II, UII-L3-III, UII-L4-I, UII-L4-II, UII-L4-III, UVI-L1-IV, UVI-L1-VII, UVI-L1-VIII	AS1-L1-UII AS1-L2-UII AS1-L4-UII AS5-L1-UVI AS6-L1-UVI	JS7-L1-UVI JS8-L1-UVI	UI 1-28 UVI 11-20	
Ff3	UI-L1-I, UI-L1-II, UI-L2-I, UI-L2-II, UI-L2-III, UII-L1-I, UII-L1-II, UII-L1-III, UII-L1-IV, UII-L2-I, UII-L2-II, UII-L3-III, UII-L4-I, UII-L4-II, UII-L4-III, UVI-L1-IV, UVI-L1-VII, UVI-L1-IX	AS1-L1-UII AS1-L2-UII AS1-L4-UII AS7-L1-UVI	JS9-L1-UVI	UI 1-28 UII 1-38 UVI 21-30	
Ff4	UI-L1-I, UI-L1-II, UI-L2-I, UI-L2-II, UI-L2-III, UII-L1-I, UII-L1-II, UII-L1-III, UII-L1-IV, UII-L2-I, UII-L2-II, UII-L3-I, UII-L3-II, UII-L3-III, UII-L4-I, UII-L4-II, UII-L4-III, UVI-L1-IV, UVI-L1-VII, UVI-L1-X	AS1-L1-UII AS1-L2-UII AS1-L4-UII AS8-L1-UVI AS3-L2-UVI	JS10-L1-UVI JS3-L2-UVI	UI 1-28 UII 1-38 UVI 31-41	

Competency	Instructional Objective	Assignment Sheet	Job Sheet	Test Item	Notes
Ff5	UI-L1-I, UI-L1-II, UI-L2-I, UI-L2-II, UI-L2-III, UII-L1-I, UII-L1-II, UII-L1-III, UII-L1-IV, UII-L2-I, UII-L2-II, UII-L3-I, UII-L3-II, UII-L3-III, UII-L4-I, UII-L4-II, UII-L4-III, UV-L1-II, UVI-L1-III, UVI-L1-VI, UVI-L2-I, UVI-L2-III	AS5-L1-UV JS6-L1-UV AS1-L1-UII AS1-L2-UII AS1-L4-UII AS1-L2-UVI AS2-L2-UVI	JS6-L1-UV JS7-L1-UV JS1-L2-UVI JS2-L2-UVI	UI 1-28 UII 1-38 UV 51-60 UVI 42-50	

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

UNIT I: INTRODUCTION TO AUTOMATIC TRANSMISSION/TRANSAXLE

UNIT OBJECTIVE

After completing this unit, the student should be able to identify the arrangement of automatic transmission/transaxle drive train components and describe the functions of major transmission and transaxle internal components.

SPECIFIC OBJECTIVES

After completing the lessons in this unit, the student should be able to:

Lesson 1: I. Identify terms and definitions associated with automatic transmission/transaxle drive train and major internal components (all competencies in the Automatic Transmission/Transaxle module).

II. Identify the operation of automatic transmission/transaxle drive train and name major components (all competencies in the Automatic Transmission/Transaxle module).

Lesson 2: I. Identify the major internal components of an automatic transmission (all competencies in the Automatic Transmission/Transaxle module).

II. Identify torque converter components (all competencies in the Automatic Transmission/Transaxle module).

III. Identify the operation of a torque converter (all competencies in the Automatic Transmission/Transaxle module).

ASE TASKS COVERED IN THIS UNIT

1. Only material that is preliminary to ASE tasks appears in this unit; therefore, no ASE tasks are covered directly.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

UNIT I: INTRODUCTION TO AUTOMATIC TRANSMISSION/TRANSAXLE

CONTENTS OF THIS UNIT

A. Objective sheet

B. References

C. Lesson plans

1. Lesson 1: AUTOMATIC TRANSMISSION/TRANSAXLE DRIVE TRAIN
    a. Information outline
2. Lesson 2: MAJOR COMPONENTS OF THE AUTOMATIC TRANSMISSION/TRANSAXLE
    a. Information outline

D. Unit test

F. Answers to unit test

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Chrysler Corporation. Automatic Transaxles and Front Drive Shafts, 1982.

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Ford Parts and Service Division. 1980 Car Shop Manual. Ford Parts and Service Division, 1980.

Ford Parts and Service Division. 1988 Car Shop Manual, Volume B. Ford Parts and Service Division, 1987.

Webster, Jay. Principles of Automatic Transmission. Prakken Publications, 1974.

NOTES TO THE INSTRUCTOR

A. Suggested audio-visual material from the Media Center, State Fair Community College, Sedalia, Mo.

   1. The Principles of the differential (AM-84-451), 1984.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

UNIT I: INTRODUCTION TO AUTOMATIC TRANSMISSION/TRANSAXLE

LESSON 1: AUTOMATIC TRANSMISSION/TRANSAXLE DRIVE TRAIN

I. Terms and definitions

A. Band--A flexible contracting friction element used to lock (hold) a planetary gear set component stationary.

B. Clutch friction--A multiple-disc friction element used to lock (hold) a planetary gear set component to another gear set or to the transmission case.

C. Differential gear set--A speed-reducing gear set located inside the transaxle of a four-wheel-drive or inside the differential housing of a rear-wheel-drive vehicle. The differential provides differential drive to the wheels from the transmission or transaxle.

D. Drive line--The drive connection between the transmission and the rear axle, consisting of a propeller shaft, universal joints, and a slip joint.

E. Four-wheel-drive--A vehicle which is driven by the front wheels and back wheels. A four-wheel-drive vehicle has a front-drive train which contains a transaxle, a four-wheel-drive shaft, and constant-velocity joints.

F. Gear ratio--The revolutions per minute (rpm) ratio between the input gear and output gear of a gear set.

G. Gear train--A succession of intermeshed gears that form an assembly that provides for torque and rpm changes.

H. Internal gear--The outer gear of a planetary gear set. The internal gear has internal gear teeth and is sometimes called a ring gear because of its ring-like appearance.

I. One-way clutch--A mechanical roller clutch used to lock (hold) planetary gear set components.

J. Planet carrier--A mechanical device that holds the pinion gears in position in the planetary gear set.

K. Planet pinions--Small gears located between the internal gear and the sun gear in a planetary gear set. Planet pinions are also known as planet gears.

L. Planetary gear set--A gear assembly containing an internal gear, pinion gears, and a sun gear, all of which are in constant mesh. The planetary gear set varies torque and rpm by varying the drive and driven gear arrangements.

M. Planetary gear set compound--An assembly of planetary gear sets used to increase the torque and rpm options.

N. Rear-wheel-drive--A vehicle which is driven by the rear wheels.

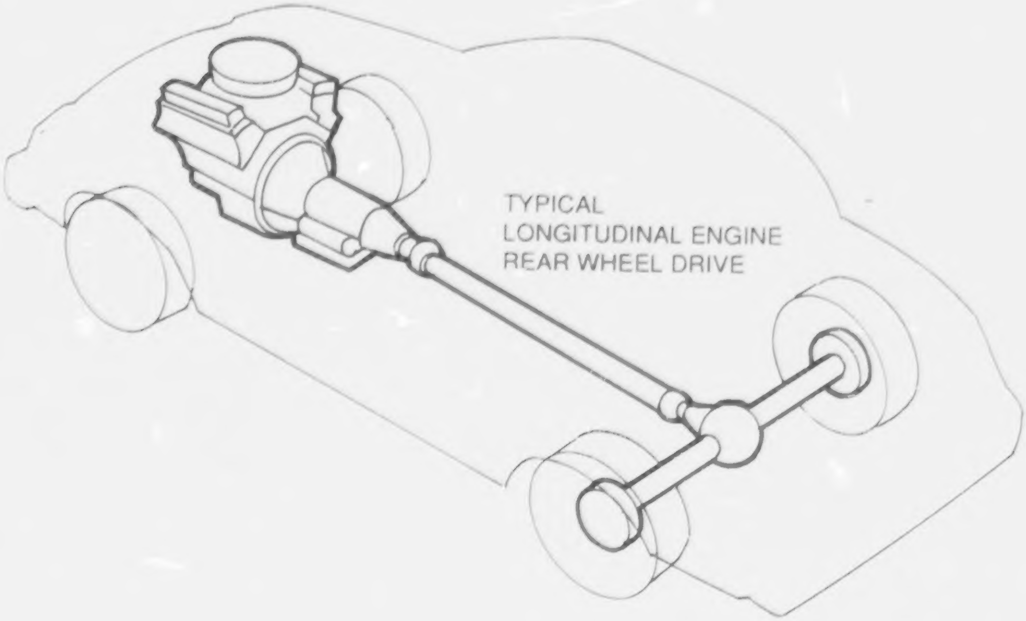
O. Sun gear--Center gear of a planetary gear set. The sun gear is in constant mesh with the planet pinions.

P. Torque converter--A hydraulic drive device that allows for fluid coupling to occur between the engine and transmission.

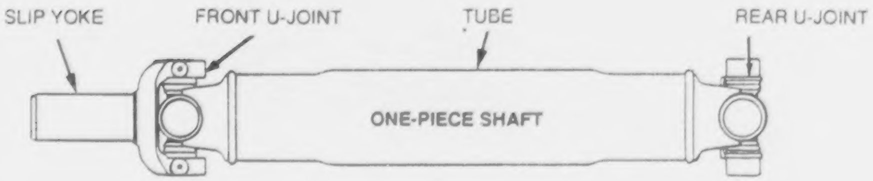
II. Automatic transmission/transaxle drive train

A. Automatic transmission drive train (rear-wheel-drive components)

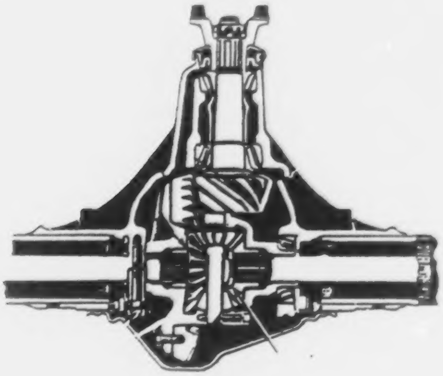
1. The automatic transmission of a rear-wheel-drive vehicle is fastened to the rear of the engine by bolts located around the transmission housing. Power from the engine is transferred through the engine flywheel and into the torque converter for distribution to the internal gear sets. The purpose of the transmission is to apply engine torque to the rear wheels in the most efficient manner possible. When the vehicle is standing still, the engine cannot develop enough torque to get the vehicle moving. The transmission converts the relatively high rpm of the engine into torque that is high enough to move the vehicle. After the vehicle begins moving, the engine continues to maintain a high rpm while the transmission provides various degrees of torque to the drive line and rear wheels.



2. The drive line consists of a slip joint, universal (hotchkiss) joints, and a drive (propeller) shaft. The drive line transmits transmission output shaft rotation and engine torque (as multiplied by the transmission) to the vehicle's drive axle. The slip joint allows for in-and-out movement caused by changes in drive line geometry. The universal joints allow for a flexible coupling between the transmission and differential assemblies.

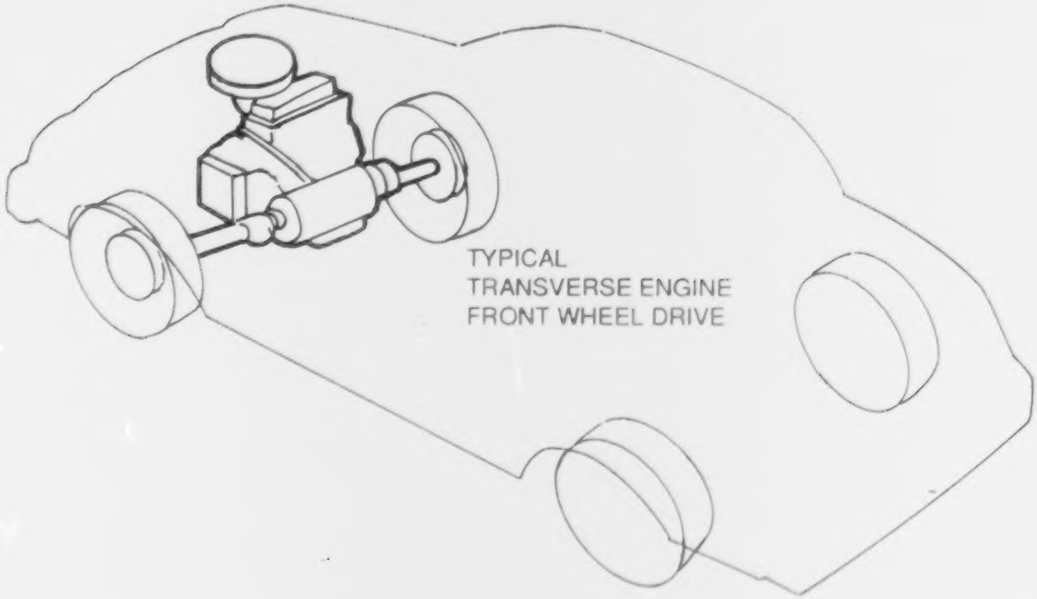


3. The differential acts as a reduction gear and torque distributor to the rear wheels. The differential transfers the output rpm and torque of the transmission into the differential housing. Through the use of the ring and pinion gears inside the differential housing, engine power is increased to its final drive level. The internal differential gears also change the direction of power flow by 90 degrees and allow for minor differences in wheel rotation caused by curves in the road.



B. Automatic transaxle drive train

1. In front-wheel-drive vehicles, a transaxle serves the same purpose as the transmission and differential in rear-wheel-drive vehicles. The transaxle transfers engine torque to the drive wheels. The engine and transaxle are transversely mounted to reduce the overall length of the drive train. The differential gears are housed in the transaxle as an integral part of the drive assembly. The differential gears are connected to the front wheels by the front-drive axles.



2. The front-drive axles transfer the final drive torque to the front wheels. Because the front wheels also steer the vehicle and are independently suspended, the drive axles must also pivot, swing, and change length. Special joints called either "rezzpa" or "constant velocity joints" are used to achieve this flexibility.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

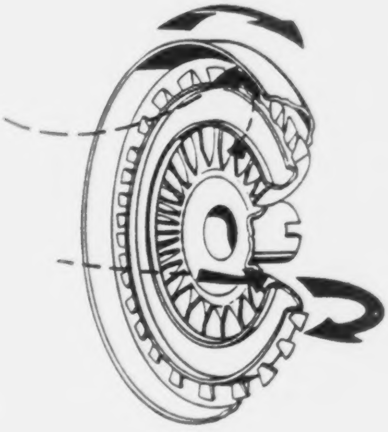
UNIT I: INTRODUCTION TO AUTOMATIC TRANSMISSION/TRANSAXLE

LESSON 2: MAJOR COMPONENTS OF THE AUTOMATIC TRANSMISSION/TRANSAXLE

I. Major components of the automatic transmission/transaxle include a torque converter, planetary gear sets, planetary holding units, and a cooling system.

II. Torque converter components

A. The torque converter pump is connected to the engine flywheel by the converter housing. As the engine rotates, the blades of the pump throw fluid outward at a high velocity. The pump, therefore, converts torque into fluid velocity.

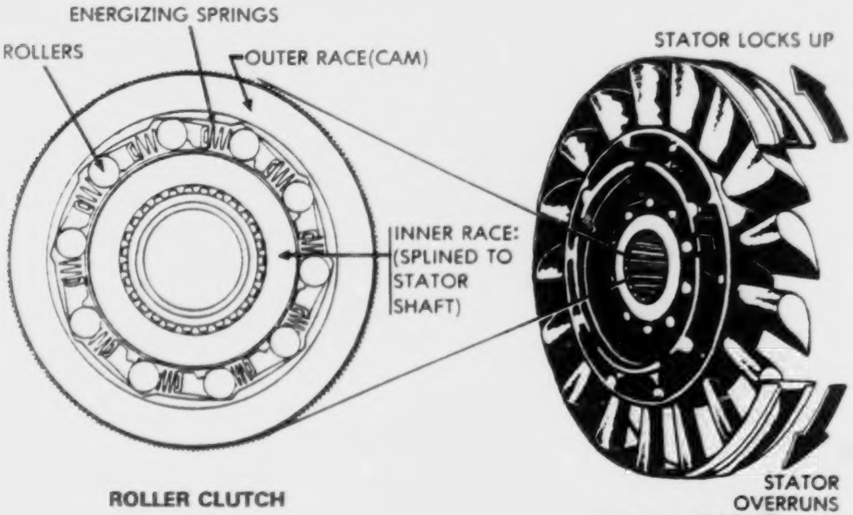


PUMP

B. The torque converter turbine is connected to the transmission input shaft. The input shaft is connected to the internal transmission gear sets. Fluid from the pump enters the turbine at high speed. Once in the turbine, the fluid strikes the turbine blades and is slowed down (but not completely stopped). As they are struck by the fluid, the turbine blades begin to move at a slower velocity but at a higher torque than the fluid. The fluid's high velocity is, therefore, converted into torque. The torque is then transferred to the internal gear sets and on to the drive wheels.

(NOTE: The blades on the turbine are curved to direct the fluid into its center. Because the fluid strikes the turbine blades at an angle, not all of the fluid velocity is converted into torque. Even after striking the blades, the fluid still is moving fairly fast and can, therefore, do more work.)

C. The stator is located in the center of the torque converter and is mounted on a one-way clutch. After the transmission fluid leaves the pump blades, it strikes the turbine. The fluid is then routed back to the pump by the stator. By routing the fluid back to the pump, the velocity maintained by the fluid is added to the velocity of the fluid leaving the pump; therefore, the force exerted on the turbine is increased. The stator allows for the multiplication of torque within the torque converter as long as the pump and turbine are turning at different speeds.



ROLLER CLUTCH

STATOR ASSEMBLY

D. When the pump and turbine are turning at the same speed, the one-way clutch allows the stator to freewheel in the direction of the pump and turbine rotation. If the difference between the pump and turbine velocity is sufficient, the clutch will lock up the stator. When the vehicle begins to accelerate from a stop, the pump is turning rapidly as a result of increased engine rpm; the turbine, on the other hand, is just beginning to turn. Because the fluid is exiting the turbine at high speed, it is striking the face of the stator blades, thus forcing them back and locking up the one-way clutch. When the clutch is locked up, the fluid is redirected to the pump as described earlier. If, however, the turbine blades are moving at the same velocity as the pump blades, the fluid will leave the turbine on the back side of the stator blades, thus rotating the stator in the same direction as the pump and turbine. Therefore, less fluid redirection occurs. The one-way clutch allows the stator to help the torque converter produce high torque at low vehicle speeds (high engine load) and low torque at high vehicle speed (low engine load).

III. Torque converter operation at various stages of engine operation

A. As the engine idles, some fluid is being forced out of the torque converter pump and into the turbine. The fluid, however, is moving very slowly and cannot strike the turbine blades hard enough to produce sufficient force to move the vehicle. In a sense, the engine has been disconnected from the vehicle drive train in much the same manner as a manual transmission is separated from the drive train by the disengagement of the clutch.

B. As the driver accelerates the engine, the pump spins faster and thus increases the fluid velocity. The fluid now strikes the turbine blades with greater velocity, thus causing the blades to turn. As the fluid leaves the turbine, it enters the stator, which is locked up by the one-way clutch, and is redirected back into the pump, striking the back of its blades and increasing the rotational speed of the pump.

C. As the engine begins to approach its maximum torque, the pump is spinning at or near the same speed as the turbine. Less fluid, therefore, needs to be redirected to the pump; a locked stator would actually block fluid return and absorb fluid velocity. The fluid leaving the turbine is moving at almost the same speed as when it entered; as it leaves, the fluid is striking the stator blades from behind. This causes the stator to unlock and rotate with the turbine.

D. If the vehicle is driven up a steep hill or is rapidly accelerated, the engine speed is again increased. The increase in engine speed, in turn, increases the pump speed. Since pump speed is greater than turbine speed, the fluid is again striking the turbine blades with greater force. The stator is again locked up; therefore, fluid is redirected into the pump until the turbine comes up to pump speed or until the engine rpm is lowered.

E. Automatic transmissions use a gear assembly called a "planetary" to change output speed and torque. Changes in output speed and torque must be made as the vehicle accelerates from a standstill to cruising speeds. A simple planetary gear set includes the following components: sun gear, set of planets and pinions, planet carrier, and internal or ring gear. By varying the drive and driven relationship between the planetary gear set components, several reductions or increases in input-to-output rpm/torque can be achieved.

1. The sun gear is located in the center of the gear set. The sun gear functions in one of the three ways described below.

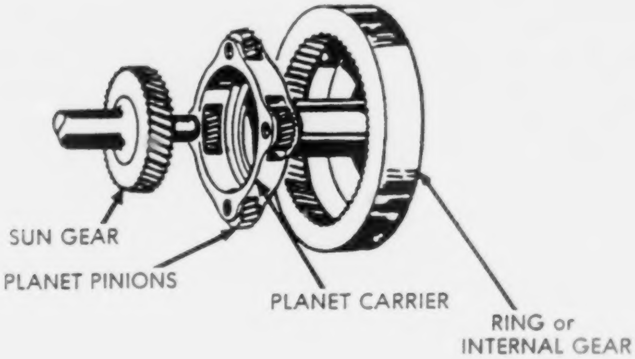
   a. The sun gear may function as the driving gear by transferring engine torque to the gear set.

   b. The sun gear may function as a driven gear.

   c. The sun gear may be simply locked in position, thus forcing the pinion gears to rotate about it.

2. The planet (pinion) gears rotate around the sun gear. Small shafts extending from the carrier base support the planet gears. Just like the sun gears, the planet gears may drive the gear set, be driven by another member of the gear set, or be locked (or held). (When the planet gears are locked, the other gear set components are forced into a reverse rotation.)

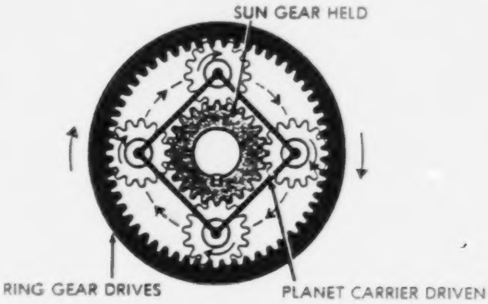
3. The internal (ring) gear is the outermost gear in the planetary set. The teeth of the internal gear mesh with the planets (pinion). The internal gear can serve as a driver, driven, or stationary gear.


SUN GEAR
PLANET PINIONS
PLANET CARRIER
RING or
INTERNAL GEAR

F. Depending on its arrangement, the planetary gear set can provide eight different speed, torque, or direction combinations. Arrangements of planetary gear sets vary, depending on the vehicle model. Some typical arrangements are listed below.

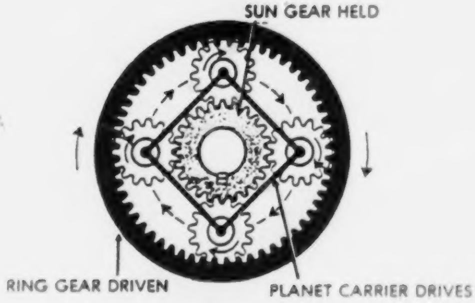
1. When the sun gear is held, the result can be either internal gear drive or planet carrier drive.

   a. In internal gear drive, the internal gear will walk the planet gear around the sun gear. This arrangement produces a forward reduction output through the planet carrier.


SUN GEAR HELD
RING GEAR DRIVES
PLANET CARRIER DRIVEN

FORWARD REDUCTION

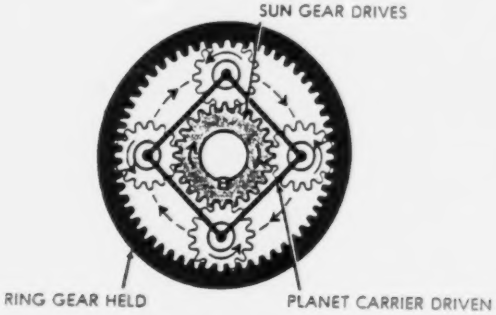
b. In planet carrier drive, the planet carrier drives the internal gear. Because this arrangement is the opposite of internal gear drive, it produces a forward gear increase in output rpm through the internal gear.


SUN GEAR HELD
RING GEAR DRIVEN
PLANET CARRIER DRIVES

FORWARD INCREASE

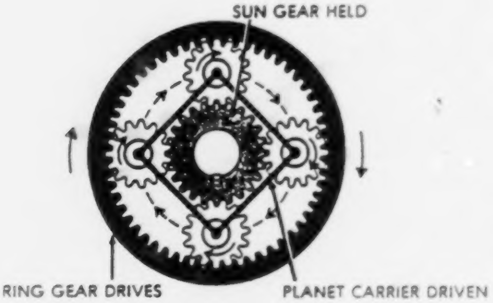
2. When the internal gear is held, the result can be either sun gear drive or planet carrier drive.

a. In sun gear drive, the sun gear drives the planet gears around the internal gear, which is held. This arrangement produces a forward reduction in carrier output.


SUN GEAR DRIVES
RING GEAR HELD
PLANET CARRIER DRIVEN

FORWARD REDUCTION

b. In planet carrier drive, the planet carrier drives the sun gear off the stationary internal gear. The planet carrier drive arrangement is the opposite of the sun gear drive arrangement. The planet carrier drive arrangement, therefore, produces a forward gear increase (overdrive) in output rpm through the sun gear.



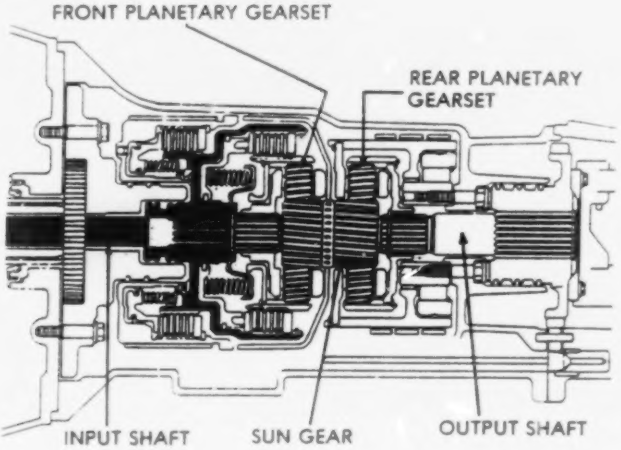
FORWARD INCREASE

c. When the planet carrier is held, either the sun gear or internal gear may be used to drive each other through the held planet carrier. When the sun gear provides input, the rpm will increase. When the internal gear provides input, the rpm will decrease. The planet carrier will create a reverse rotation if locked between the internal gear and sun gear.

d. If any two members of the planetary set are held, a locked gear set (direct drive) results. When the two members are held, there is no reduction, increase, or direction change; torque is simply passed through.

e. If all members are released (free to turn), then the transmission is in neutral.

G. Two or more simple planetary sets can be combined into one assembly called a compound planetary gear set. Because of its combination of gear sets, the compound planetary gear set allows for a larger range of torque and rpm inputs and outputs in a relatively small, lightweight unit. The compound planetary gear set operates according to the same principle as a simple planetary set; however, the compound set offers more options for distribution of power to the wheels.



H. In an automatic transmission, gear ratios are changing the drive/driven relationship between members of a planetary gear set. In most automatic transmissions, changes in the drive/driven relationship are achieved through the use of multiple disc clutches, bands, and one-way clutches.

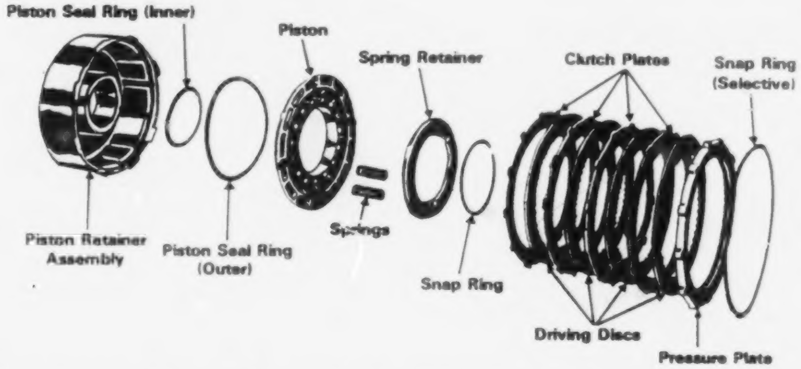
1. Depending upon the transmission design, the multiple disc clutch can be used either to hold planetary members or to connect them to input or output shafts. A multiple disc clutch is made up of a clutch housing, a clutch piston, a return spring or springs (either a single spring, multiple coil spring, or a bellville spring), a piston seal, a set of friction discs, and a set of steel discs.

   a. The multiple disc clutch housing can be either integral with the case or mounted on the input or output shafts. The multiple disc clutch allows for a sealing area for the piston seals. The clutch also includes a set of splines that mesh with the clutch disc and a system (or sometimes a set of return springs) for piston return.

   b. The clutch piston applies pressure to the return springs and forces the friction disc into contact with the steel disc, locking them together. (The clutch piston itself is activated by hydraulic pressure.) The piston seals are usually made of neoprene, but are occasionally made of cast iron. The piston receives hydraulic pressure through drilled passages in the transmission case or through rifled shafts.

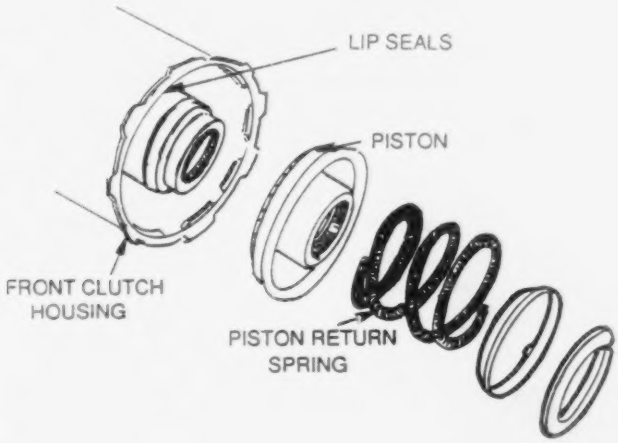
c. The automatic transmission clutch makes use of multiple friction discs, which allow for a variety of friction surfaces in a small area. The friction discs require no external adjustment and reduce parts failure due to stress. The friction materials used on the face of the discs (cork, cotton, and paper) allow for good frictional contact with the steel disc without significant loss of friction material.

d. The automatic transmission clutch also uses steel discs, which are stacked alternatively with the friction disc. As the piston compresses the clutch pack, the friction discs contact and bind to the steel discs and lock the two units together. To reduce wear, grooves in the friction disc reduce heat during application. Some units use a wavy steel plate to absorb shocks within the clutch pack.

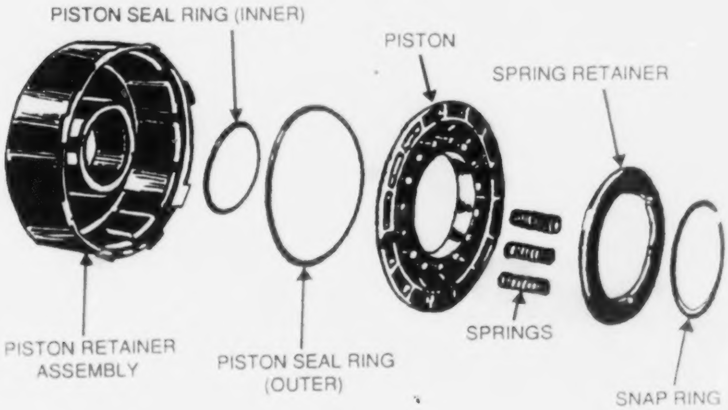

Piston Seal Ring (Inner)
Piston
Spring Retainer
Clutch Plates
Snap Ring (Selective)
Piston Retainer Assembly
Piston Seal Ring (Outer)
Springs
Snap Ring
Driving Discs
Pressure Plate

e. Some automatic transmission clutches use a single coil spring to return the piston to the rest position after the removal of hydraulic pressure. The single coil spring system includes a large coiled spring that rests on the piston face and spring retainer. The spring retainer is a part of the housing.-

(NOTE: The rate of piston return is determined by the spring size and piston leak-down rate; therefore, springs from one assembly should not be used on another.)

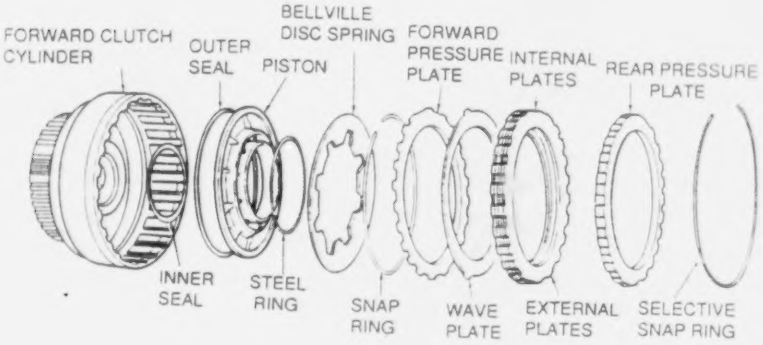

LIP SEALS
PISTON
FRONT CLUTCH HOUSING
PISTON RETURN SPRING

f. Some automatic transmissions use multiple coil springs. One of the coil ends rests on extrusions or hollows molded in the piston; the other end rests against the retainer. The number, location, and size of the springs determine the rate of piston return; therefore, do not mix springs with other units or place them in the wrong order upon assembly.


PISTON SEAL RING (INNER)
PISTON
SPRING RETAINER
SPRINGS
SNAP RING
PISTON RETAINER ASSEMBLY
PISTON SEAL RING (OUTER)

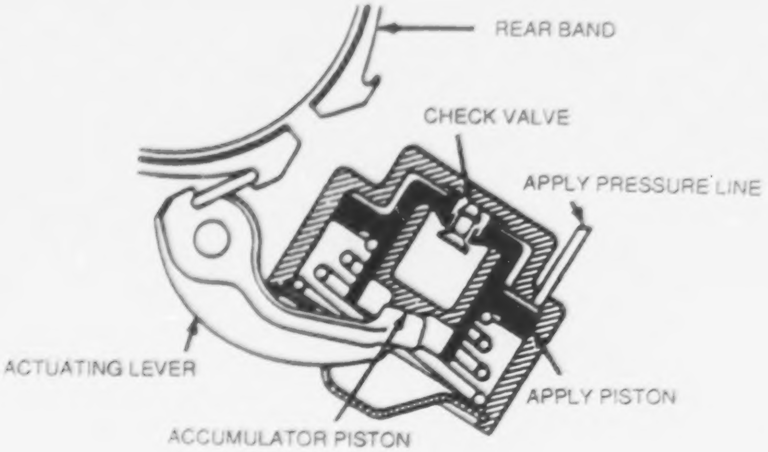
g. Some automatic transmissions use a bellville or disc spring, which is a disc that is cupped in one direction. When the piston is applied, it flattens the cup. When hydraulic pressure on the piston is released, the disc returns to its original cup shape and thereby forces the piston to return to its rest position.

(NOTE: During assembly, be sure to place the bellville spring in the proper direction.)


FORWARD CLUTCH CYLINDER
OUTER SEAL
PISTON
BELLVILLE DISC SPRING
FORWARD PRESSURE PLATE
INTERNAL PLATES
REAR PRESSURE PLATE
INNER SEAL
STEEL RING
SNAP RING
WAVE PLATE
EXTERNAL PLATES
SELECTIVE SNAP RING

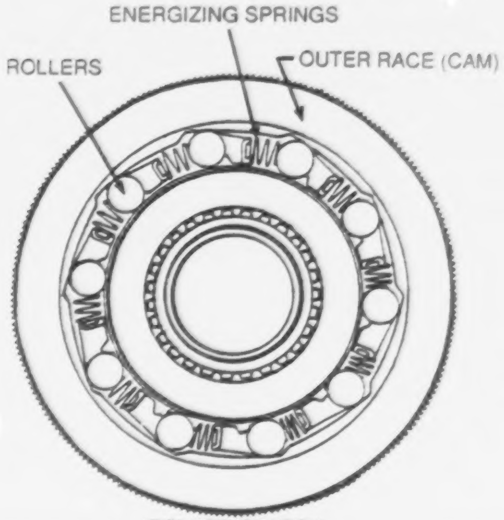
2. The band and servo assembly consists of a friction band, a piston, a stem, and a return spring. Hydraulic pressure is routed to the servo piston which compresses

the band around the drum. Since the band is anchored at the other end, the band is prevented from rotating. When the fluid pressure is released, the band is relaxed by the piston return spring. Most band and servos have an adjustable anchor to compensate for wear.


REAR BAND
CHECK VALVE
APPLY PRESSURE LINE
ACTUATING LEVER
APPLY PISTON
ACCUMULATOR PISTON

3. The one-way clutch holds a planetary member when it begins to rotate in one direction and allows it to rotate freely in the opposite direction. The one-way clutch will be either the roller or sprag type.

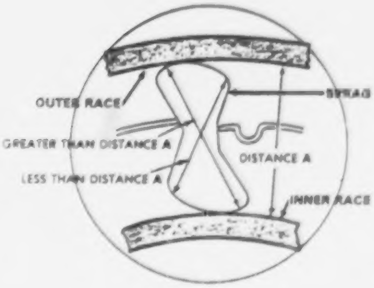
a. The roller-type one-way clutch consists of an inner and outer race, a set of rollers and a set of roller springs. When the inner race turns clockwise, the rollers are pushed up into the grooves cut in the outer race. This pushing up of the rollers collapses the springs and allows freewheeling. When the inner race is rotated counter clockwise, spring tension and the rotation of the race push the rollers into the narrow part of the outer race, locking the races together.

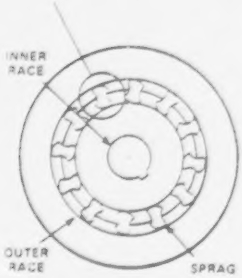


ROLLER CLUTCH

COUNTERCLOCKWISE FORCES ON CAM LOCK ROLLERS TO INNER RACE.
CLOCKWISE FORCES ON CAM CAUSE ROLLERS TO OVERRUN INNER RACE. -

b. The sprag clutch uses sprags, which are specially shaped pieces of steel with a wide end and a narrow end. As the inner race rotates in the proper direction, the sprags are rolled to their narrow ends and allow the race to freewheel. If the race is rotated in the opposite (or improper) direction, the wide end of the sprag is rolled into contact with the outer race, thus locking the races together.

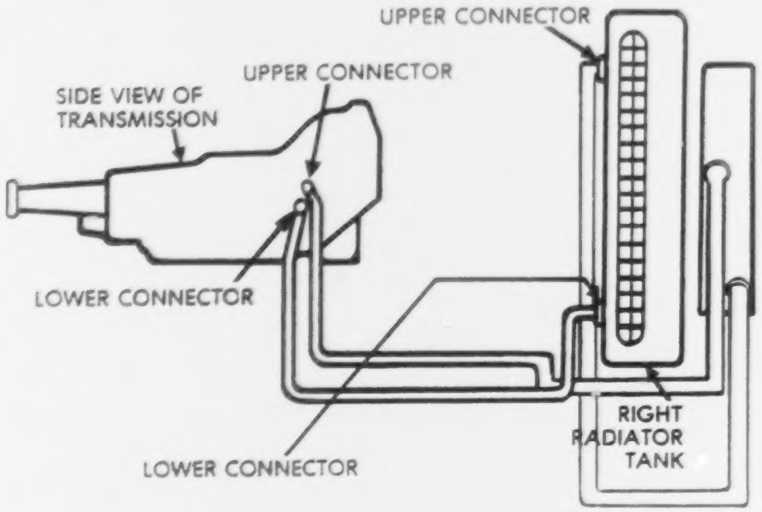




I. Cooling systems are required for automatic transmissions. Operation of the torque converter, clutch and band slippage, and other activity can cause the transmission fluid to become very hot. A cooling system must be provided to maintain fluid temperature between 150 and 250 degrees Fahrenheit. Two common devices used to cool automatic transmission fluid are the radiator heat exchanger and the auxiliary cooler.

1. Most manufacturers use the radiator heat exchanger to cool the transmission fluid. Fluid is pumped at a reduced rate from the transmission into a heat exchanger located in the engine radiator.

2. When automatic transmissions are used in extremely adverse conditions (such as hot climates) or placed under a heavy load, an auxiliary cooler can be used to increase the cooling capacity of the cooling system. Auxiliary coolers are mounted in front of the vehicle radiator and are placed in series with the original equipment cooler. Hydraulic fluid passes through both the original cooler and the auxiliary cooler before returning to the transmission.


UPPER CONNECTOR
UPPER CONNECTOR
SIDE VIEW OF TRANSMISSION
LOWER CONNECTOR
RIGHT RADIATOR TANK
LOWER CONNECTOR

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

UNIT I: INTRODUCTION TO AUTOMATIC TRANSMISSION/TRANSAXLE

UNIT I TEST

SECTION A. **Read the statements below. Place a T or F in the blank beside each statement to indicate whether it is true or false.**

____ 1. Gear ratio is the input gear rpm in relation to the output gear rpm.

____ 2. The sun gear is an outer ring-like gear in a planetary gear set.

____ 3. A pinion is a multiple disc friction element used to lock (hold) a planetary gear set component to another gear set or the transmission case.

____ 4. A band is a flexible contracting friction element used to lock (hold) a planetary gear set component.

____ 5. A planetary gear set includes an internal gear, a sun gear, and planet gears.

____ 6. A torque converter is a hydraulic device that provides fluid coupling.

____ 7. The planet carrier is the center gear of the planetary gear set.

____ 8. The internal gear is located between the sun and planet gears of a planetary gear set.

____ 9. The clutch is a mechanical device that holds pinion gears in position in the planetary gear set.

____ 10. A transmission can convert high RPM to low RPM.

____ 11. A drive line and a drive shaft are the same device.

____ 12. The differential changes the direction of power flow by 45 degrees.

____ 13. The differential allows the vehicle's drive wheels to turn at different speeds.

____ 14. Front-wheel-drive axles must pivot, swing, and change length.

____ 15. A constant velocity joint and a rezzpa joint are the same name for a component.

____ 16. A band is usually considered superior to a multiple disc clutch.

____ 17. One-way clutches are sometimes used to hold planetary gear sets.

____ 18. Transmission cooler systems often run transmission fluid through the radiator.

____ 19. A single coil piston return spring is used in some multiple disc clutches.

SECTION B. **Select the best answer from the five choices listed.**

____ 20. The portion of the torque converter connected to the flywheel is

a. the pump.
b. the turbine.
c. the stator.
d. the one-way clutch.
e. none of the above.

____ 21. The part of the torque converter connected to the transmission input shaft is

a. the pump.
b. the stator.
c. the turbine.
d. the one-way clutch.
e. none of the above.

____ 22. The part of the torque converter that directs fluid flow inside the torque converter is

a. the pump.
b. the stator.
c. the turbine.
d. the one-way clutch.
e. all the above.

____ 23. Compound planetary gear sets are used to

a. lower the range of torque/rpm inputs and outputs.
b. increase the range of torque/rpm inputs and outputs.
c. add strength to the drive train.
d. add load-carrying capacity to the transmission.
e. do none of the above.

____ 24. Clutch packs are applied with

a. spring pressure.
b. pneumatic pressure.
c. hydraulic pressure.
d. mechanical pressure.
e. none of the above.

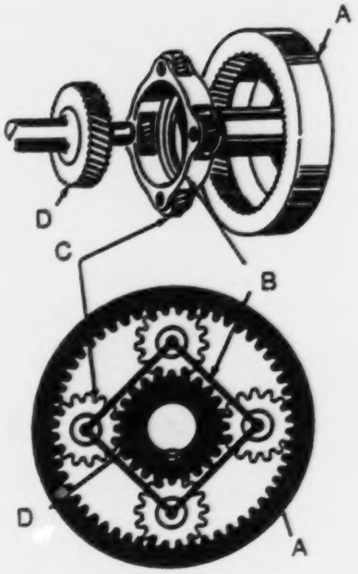
SECTION C. **Match the component name on the left to its correct part on the right.**

___ 25. Sun gear

___ 26. Planet gear

___ 27. Planet carrier

___ 28. Ring or internal gear



ATT 27

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

UNIT I: INTRODUCTION TO AUTOMATIC TRANSMISSION/TRANSAXLE

ANSWERS TO UNIT I TEST

1. t
2. f
3. f
4. t
5. t
6. t
7. f
8. f
9. t
10. t
11. f
12. f
13. t
14. t
15. t
16. f
17. t
18. t
19. t
20. a
21. c
22. b
23. b
24. c
25. d
26. c
27. b
28. a

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

UNIT II: HYDRAULIC CONTROL SYSTEMS

UNIT OBJECTIVE

After completing this unit, the student should be able to describe fundamental principles of hydraulics and the manner in which they are applied in automatic transmission control systems. The student will demonstrate mastery of the material by achieving a score of ____ on the unit test.

SPECIFIC OBJECTIVES

After completing the lessons in this unit, the student should be able to:

Lesson 1. I. Identify terms and definitions associated with automatic transmission hydraulic control systems (all competencies in the Automatic Transmission/Transaxle module, Unit II Test).

II. Identify the operating principles of a simple hydraulic system (all competencies in the Automatic Transmission/Transaxle module, Unit II Test)

III. Identify the basic components of a hydraulic system (all competencies in the Automatic Transmission/Transaxle module, Unit II Test).

IV. Describe the basic operation of a hydraulic system (all competencies in the Automatic Transmission/Transaxle module, Unit II Test).

Lesson 2. I. Identify the basic types of hydraulic pumps used in automatic transmissions and the principles by which the pumps operate (all competencies in the Automatic Transmission/Transaxle module, Unit II Test).

II. Identify the basic types of hydraulic valves used in automatic transmissions and the principles by which the valves operate (all competencies in the Automatic Transmission/Transaxle module, Unit II Test).

Lesson 3. I. Identify the components that control fluid pressure within an automatic transmission (all competencies in the Automatic Transmission/Transaxle module, Unit II Test).

II. Identify the operating principles of the shift control system within an automatic transmission (all competencies in the Automatic Transmission/Transaxle module, Unit II Test).

III. Identify the operating principles of a transmission fluid control unit (all competencies in the Automatic Transmission/Transaxle module, Unit II Test).

Lesson 4. I. Identify the characteristics of automatic transmission fluid (all competencies in the Automatic Transmission/Transaxle module, Unit II Test).

II. Identify the various types of seals used in an automatic transmission (all competencies in the Automatic Transmission/Transaxle module, Unit II Test).

III. Identify the procedures for seal inspection and installation (all competencies in the Automatic Transmission/Transaxle module, Unit II Test).

ASE TASKS COVERED IN THIS UNIT

I. Only material that is preliminary to ASE tasks appears in this unit; therefore, no ASE tasks are covered directly.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

UNIT II: HYDRAULIC CONTROL SYSTEMS

CONTENTS OF THIS UNIT

A. Objective sheet

B. References

C. Notes to the instructor

D. Lesson plans

  1. Lesson 1: THE BASIC COMPONENTS AND PRINCIPLES OF HYDRAULIC SYSTEMS
    a. Information outline
    b. Assignment sheet
      AS1-L1-UII: Basic Principles of Hydraulics
  2. Lesson 2: AUTOMATIC TRANSMISSION PUMPS AND VALVES
    a. Information outline
    b. Assignment sheet
      AS1-L2-UII: Automatic Transmission Control Devices
  3. Lesson 3: FUNDAMENTALS OF HYDRAULIC CONTROL
    a. Information outline
  4. Lesson 4: HYDRAULIC SEALS AND FLUID
    a. Information outline
    b. Assignment sheet
      AS1-L4-UII: Transmission Fluid and Transmission Seals

E. Unit test

F. Answers to unit test

REFERENCES

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NOTES TO THE INSTRUCTOR

A. Suggested approaches to teaching this unit

    1. Students should do AS1-L1-UII, AS1-L2-UII, and AS1-L4-UII before taking the unit test.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

UNIT II: HYDRAULIC CONTROL SYSTEMS

LESSON 1: THE BASIC COMPONENTS AND PRINCIPLES OF HYDRAULIC SYSTEMS

I. Terms and definitions

A. Accumulator--A hydraulic device used to reduce harsh shifting of the transmission by absorbing rapid shock or surge in the hydraulic control system.

B. Annular groove (spool valve groove)--Grooved area between lands on a cylindrical valve of a precision machine. The annular groove is used in conjunction with a round bore to control hydraulic fluid.

C. ATF--Abbreviation for automatic transmission fluid.

D. Boost valve--A hydraulic spool valve that works with the main pressure regulating valve to maintain mainline pressure during adverse shifting conditions.

E. Check valve--A device that allows fluid to pass freely in one direction while restricting its flow in the opposite direction.

F. Crescent (gear) pump--A pump used to provide mainline oil pressure. A crescent-shaped divider is located between the pump's inlet and outlet.

G. Detent valve--A valve that forces the transmission to downshift as a result of rapid W.O.T. acceleration.

H. Dexron IID--A type of automatic transmission fluid that meets manufacturers' specifications for most late-model vehicles.

I. F, FA--A type of automatic transmission fluid that meets some manufacturers' specifications.

J. Force--The push or pull that causes an object to move. Force is measured in pounds or newtons.

K. Governor pressure--Hydraulic pressure that is related to transmission output rpm. Governor pressure is used to control the shift point.

L. Lubricity--A measure of a fluid's ability to reduce friction between moving objects that are in contact with one another.

M. Mainline pressure--The major fluid supply circuit for hydraulically controlled components.

N. Manual valve--A valve used to select the operating mode of the transmission. The manual valve is connected to the shift lever by a linkage.

O. Modulator valve--A valve that varies the shift point on the basis of engine vacuum and that overrides the governor's shift signal.

P. Orifice--A narrowed opening in a fluid passage used to regulate pressure and flow through the passage.

Q. Oxidation resistance--A measure of a transmission fluid's ability to resist oxidation. Such oxidation of transmission components produces sludge within the transmission.

R. Pascal's law--Physical descriptions of phenomena connected with the flow of fluids.

S. Positive displacement pump--A pump whose output is predictable at an established rpm, measured in psi and gpm.

T. Pressure regulating valve--A hydraulic control valve used to regulate the pressure of the mainline fluid system.

U. Relief valve--A hydraulic control valve that is activated when hydraulic pressure reaches a predetermined level. The relief valve vents or exhausts excessive fluid pressure.

V. Shift valve--A hydraulic control valve that causes an up or down shifting of the transmission.

W. Spool valve--Cylindrically shaped valve with grooves between sealing lands. The spool valve activates hydraulic controls according to their position in the cylinder bore.

X. Throttle valve--A hydraulic control valve connected to the engine accelerator pedal by a linkage. The throttle valve controls the shift points of a transmission on the basis of throttle opening. The throttle valve also overrides the governor shift signal.

Y. Viscosity--A measure of a fluid's thickness at a given temperature.

Z. Viscosity index--The degree of change in a fluid's viscosity that occurs with a relative change in temperature.

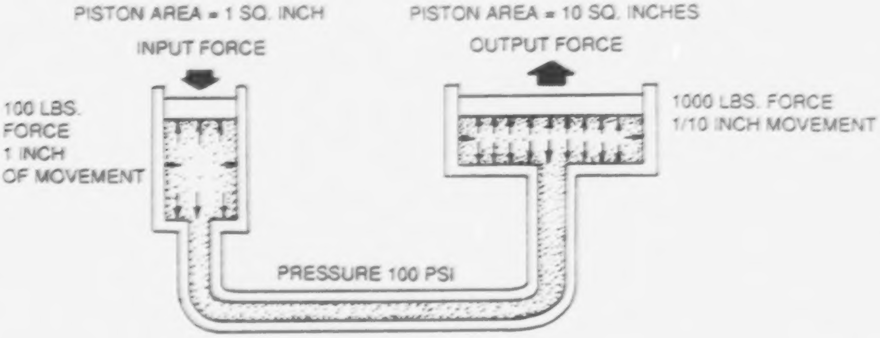
II. Principles of hydraulics

A. In the seventeenth century, a French physicist named Pascal proved that force and motion could be transferred via enclosed fluid. Pascal also proved that mechanical advantage can be obtained by incorporating different sizes of pistons into a hydraulic system.

1. Pascal's first law states that fluid is not compressible. If, for example, a stopper was forced down the neck of a bottle that was completely filled with water, the liquid would not be compressed by the stopper. Even if extreme pressure were applied to the stopper, the bottle might break yet the fluid would still not be compressed.

2. Pascal's second law states that, if pressure is exerted on a confined liquid, the liquid will exert the pressure equally in all directions. If a force is applied to the surface of a liquid in a container, the force will be transferred equally throughout the container. The force would in no way be diminished by the size or shape of the container. The force transferred through the fluid is measured in pounds of force exerted against square inches of area.

3. Pascal's third law states that pressure acts with equal force on all areas which it contacts. Because of its ability to exert pressure equally, hydraulic force is able to create a mechanical advantage. In short, the greater the area of the hydraulic output device, the more force that will be developed. On the other hand, the smaller the area of a hydraulic output device, the less the force that will be developed.


PISTON AREA = 1 SQ. INCH
INPUT FORCE
PISTON AREA = 10 SQ. INCHES
OUTPUT FORCE
100 LBS. FORCE 1 INCH OF MOVEMENT
1000 LBS. FORCE 1/10 INCH MOVEMENT
PRESSURE 100 PSI

4. Pascal's fourth law states that fluid transmits motion. Fluids can be used to transmit motion through the use of pistons and cylinders. If the piston delivering the pressure or motion (the input piston) is the same size as the piston receiving the pressure or motion (the output piston), then the force and motion potential of the output piston will be the same as the force applied by the input piston. If the input piston is smaller than the output piston, then the force potential of the output piston will be increased (i.e. greater than the input piston), but the motion potential will be decreased (i.e. less than the input piston). Stated another way, a small input piston can cause a larger output piston to develop greater force (though the distance traveled by the larger output piston will decrease). This is an example of mechanical advantage.

B. Fluid flow within a hydraulic system is always created by a pressure difference within the system. Fluid flow will continue until it is blocked or until the pressure difference is eliminated.

C. When a fluid flows through an orifice, there is an increase in its velocity and a decrease in its pressure for as long as the flow continues. When pressure equalizes and fluid flow ceases, then no pressure drop occurs across the orifice.

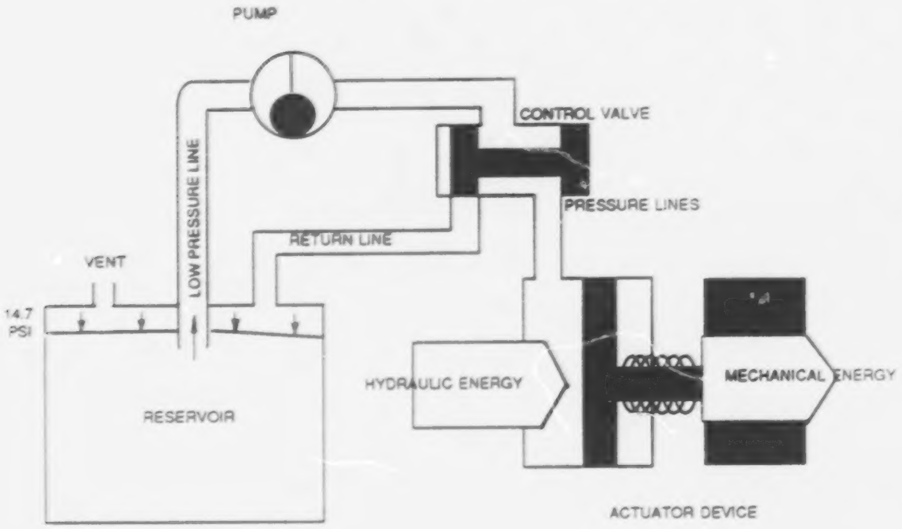
III. Basic components of a hydraulic system

A. In most hydraulic systems, the reservoir is a storehouse for fluid. In most automatic transmissions, the reservoir provides the fluid pump with an abundant supply of fluid. The reservoir is usually vented to allow atmospheric pressure to be exerted against the fluid's surface.

B. A pump creates a pressure difference in the hydraulic system, causing the flow of fluid. The rate of flow will be determined by the output of the pump versus the resistance that the fluid encounters.

C. In most hydraulic systems, some sort of control device determines the direction in which the fluid moves and the rate at which the fluid flows.

D. Hydraulic systems often use an actuator to transfer hydraulic pressure into mechanical force. In most cases, hydraulic pressure is applied to the surface of a piston. The piston is then moved and usually applies force to some other mechanical components, thus converting hydraulic force to mechanical force. The amount of the force the piston is able to apply to another component equals the amount of hydraulic pressure transferred to the piston from the actuator multiplied by the area of the piston.



IV. Basic operation of a hydraulic system

A. The pump creates a pressure drop on the line leading to the reservoir. Atmospheric pressure exerts 14.7 psi of force on the surface of the fluid. Since a pressure difference exists between the pump and the reservoir, fluid flows from the reservoir through the low pressure line to the pump.

B. The pump forces the fluid into the mainline of the hydraulic system, raising its pressure. The amount of pressure will depend upon the rate of pump output and the resistance to fluid flow in the system.

C. The fluid flows under pressure to the control valve. Depending on the position of the control valve, the fluid may be routed in two different directions.

D. When the valve opens the return line, the fluid is allowed to return to the reservoir and, therefore, accomplishes no work. Since the fluid is flowing freely back to the reservoir, the mainline pressure is low.

E. When the valve closes the return line and opens the actuator line, fluid is directed to an actuator mechanism. Since the fluid will no longer be flowing freely, a greater resistance to fluid flow will then develop on the actuator side of the system, thus causing mainline pressure to rise.

F. As fluid pressure is applied to the piston surface, force is exerted against the piston rod, allowing the piston to accomplish mechanical work. Mainline pressure will be at its highest when the actuator is fully applied.

G. When the control valve once again opens the return line, fluid pressure is denied to the actuator and the piston returns to its original position. Fluid that remains in the piston area is displaced to the reservoir through the return line.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

BASIC PRINCIPLES OF HYDRAULICS

Instructions: **Do the following tasks and answer the following questions. Write all responses on this sheet.**

1. Describe the relationship between fluid pressure and the surface area against which it is exerted.

2. Describe how fluid flow is created in a hydraulic system.

3. Describe the role of an orifice in a hydraulic system.

4. Describe the role of a reservoir in a hydraulic system.

5. Describe the role of a hydraulic system fluid pump.

6. Describe the role of an actuator in a hydraulic system.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

BASIC PRINCIPLES OF HYDRAULICS

(ANSWER SHEET)

1. Pascal's third law states that pressure acts with equal force on all areas which it contacts. For example, imagine two pistons, one large and one small, both of which are connected by a hose or line filled with hydraulic fluid. If the smaller piston applies 5 psi of pressure to the fluid, then the larger piston will move (less distance than smaller piston, however) and apply 5 psi of pressure to whatever it contacts. The larger piston will, however, apply the 5 psi over a larger area, thus achieving a multiplication of force. It is important to emphasize that the larger piston will move less distance than the smaller piston, thus making multiplication of force possible.

2. Fluid flow within a hydraulic system is always created by a pressure difference within the system.

3. When fluid flows through an orifice, the fluid's velocity increases while its pressure decreases. When pressure equalizes and fluid flow ceases, then no pressure drop occurs across the orifice.

4. The reservoir is a storehouse for automatic transmission fluid. The reservoir provides the automatic transmission fluid pump with an abundant supply of fluid.

5. The automatic transmission pump creates a pressure difference in the system, creating fluid flow.

6. An actuator translates hydraulic pressure into mechanical force.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

UNIT II: HYDRAULIC CONTROL SYSTEMS

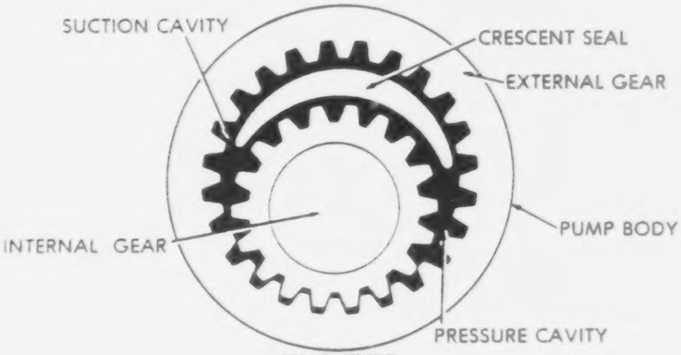
LESSON 2: AUTOMATIC TRANSMISSION PUMPS AND VALVES

I. Automatic transmission pumps

  A. Automatic transmissions use a variety of rotary pumps to provide mainline pressure. The pumps are usually driven by a hub on the torque converter. In some older model vehicles with dual pumps, the transmission output shaft drives a second auxiliary pump. Rotating members of the pump create clearance areas that change in shape and size, depending on their relative position to each other. Fluid is pulled into the pump when a void is created by the rotating pump gears. Fluid is expelled from the pump by shrinking chambers that squeeze the fluid out of the outlet port. Because the construction of the chambers allows very little leakage, the pump exhausts a predictable volume of fluid upon each rotation. These pumps are, therefore, called positive displacement pumps.

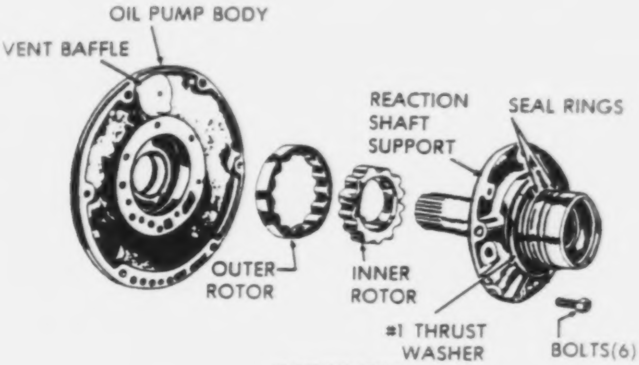
  B. Types of automatic transmission pumps

    1. Some automatic transmission pumps have a center (internal) drive gear, which is connected to the torque converter by lugs or drive flats. These pumps also have an external (outer) driven gear, which is meshed to the internal gear. The space between the meshed teeth becomes larger and smaller as the gears rotate, thus drawing fluid into and discharging it out of its outlet. A crescent-shaped divider separates the two gears; oil is trapped between the divider and the gear teeth of both gears.



GEAR TYPE

2. The lobe pump is similar to the gear pump in appearance and operation. The gear teeth of the lobe pump, however, are rounded and larger in size. The lobe pump also does not use a dividing crescent but instead relies on the changing volume of the chambers (made by the lobe) to draw oil into the pump and then force it out.



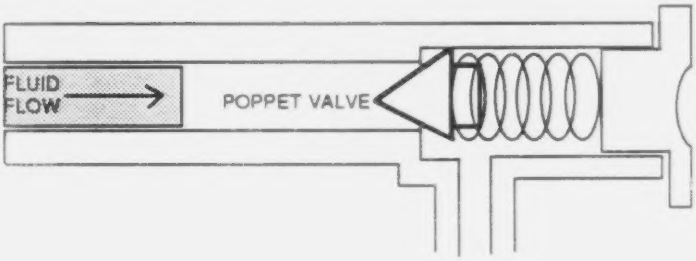
ROTOR TYPE

3. The vane pump uses a set of vanes that are rotated by a driving rotor. As the vanes rotate, they slide in and out of an eccentrically shaped chamber. The subsequent change in size of the chambers between the vanes produces the suction and discharge of the pump. There are some vane pumps that use a sliding eccentric that can vary the pump's output; these pumps are called variable vane pumps. By varying the output of the pump, less torque is needed to drive the pump when demand on the system is low.

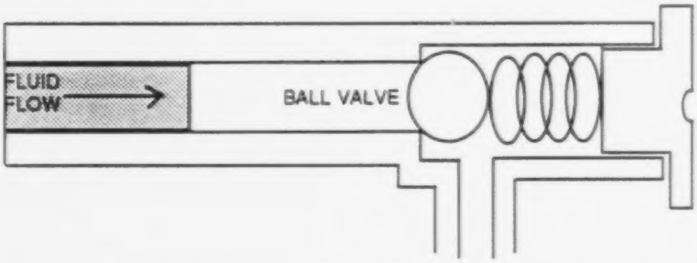
C. To maintain mainline fluid pressures at specified levels, automatic transmission systems use a pressure regulation system and a protective high-pressure relief system. (The level of pressure desired depends upon the mode in which the transmission is operating.) Listed below are some of the valves used in these pressure regulation and relief systems.

1. The pressure relief valve is a spring-loaded device that is forced open by excessive mainline pressure. When the valve is forced open, it directs the excessive pump output directly back to the pump. The size of the valve opening and the tension on the check spring determine the relief pressure point. Either poppet valves or ball relief valves are used as pressure relief valves.

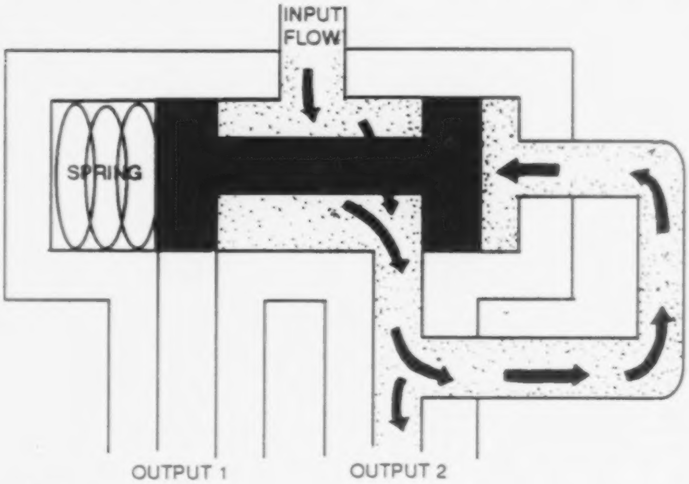
a. The poppet relief valve uses a round disc or a tapered needle valve to close the port opening.



b. The ball relief valve uses a round ball to close the port opening.



2. Unlike the simple relief valve, the pressure regulation valve can vary its response to changes in mainline pressure according to the operating mode of the transmission. Spring tension is balanced against reaction pressure to produce a modulating pressure. Pressure from a third source is applied behind the spring tension in order to create an output pressure based upon spring tension plus auxiliary PSI/area versus reaction pressure. This is sometimes called boost pressure because it raises the regulated pressure level of the mainline. The auxiliary pressure, therefore, does not have to depend solely on pump output versus system resistance as a basis for influencing the mainline pressure.



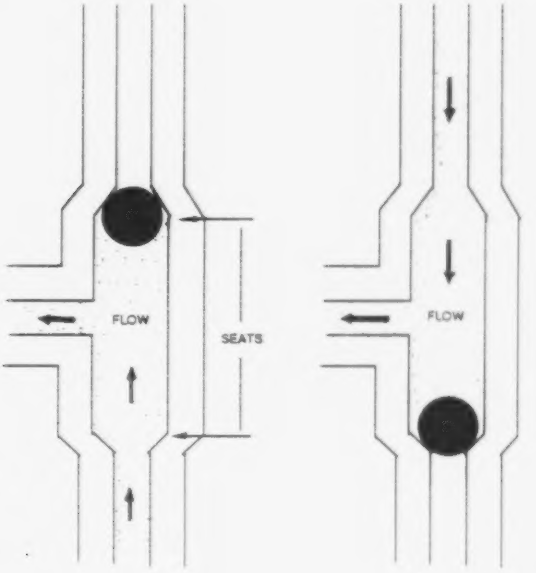
II. Basic hydraulic valves

(NOTE: Relief and pressure valves are the major pressure-regulating devices within an automatic transmission system. Most automatic transmissions, however, use a host of other valves or valve combinations to control the transmission operating modes. These valves are discussed below.)

A. The check valve is a simple one-way directional control valve. The check valve permits fluid to flow in one direction while restricting fluid flow in the opposite direction. The various types of check valves include the single-seat ball check valve, the dual-seat ball check valve, and the poppet check valve.

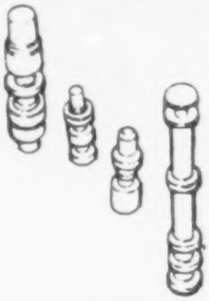
1. The single-seat ball check valve consists of a steel or nylon ball and a seat. When automatic transmission fluid pressure is applied on the seat side of the valve, the ball is forced off the seat and fluid is permitted to flow in one direction. When pressure is applied to the opposite side of the valve, the ball is pushed into its seat, sealing fluid flow in the opposite direction.

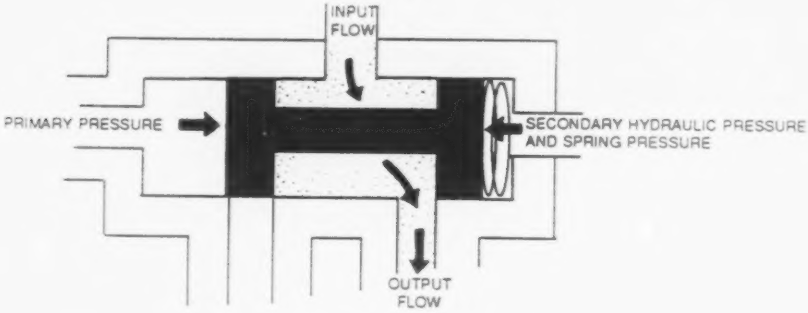
2. The dual-seat ball check allows fluid flow from two different sources to act on a single outlet in the automatic transmission. The ball check is used to direct fluid flow down the outlet.


FLOW
SEATS
FLOW

3. Instead of a ball, the poppet check valve uses a disc made of either nylon, neoprene, or steel. The poppet valve operates in a manner identical to the ball check valve.

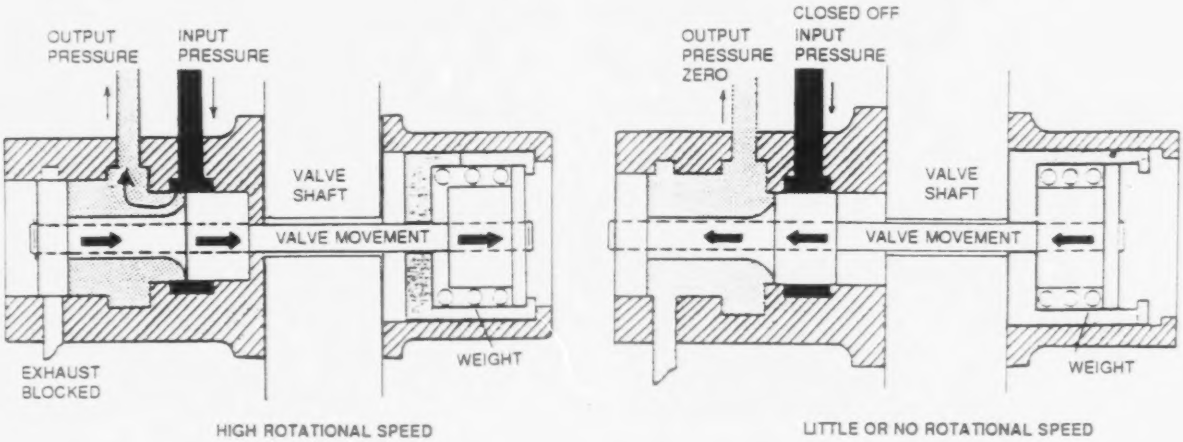
B. A spool valve is a machined, cylindrically shaped valve, which has grooved (annular) areas between smooth sealing lands. When used in a bore, the lands can be aligned to allow or prohibit the flow of automatic transmission fluid through the valve. A spool valve may be positioned by spring tension, hydraulic pressure, or mechanical linkage.




INPUT FLOW
PRIMARY PRESSURE
SECONDARY HYDRAULIC PRESSURE AND SPRING PRESSURE
OUTPUT FLOW

C. The relay valve is a kind of hydraulic switch that allows or prohibits the flow of automatic transmission fluid on the basis of an external mechanical or hydraulic force. The relay valve is used when a weak force must act upon a strong hydraulic force or when dissimilar forces must interact.

D. The centrifugal valve governor uses rotational speed to generate or meter a fluid flow based upon the rpm of the transmission output shaft (the vehicle drive shaft). In an automatic transmission system, the transmission governor is the only example of a centrifugal valve. The output signal of the centrifugal valve is, nevertheless, essential to proper shifting. The valve is mounted on the output shaft and has a set of spool valves that are thrown outward by rotational force against spring or hydraulic balancing force. The further the spool valves move out, the higher the output pressure through the valve.



E. The accumulator is used to absorb hydraulic shock or to delay pressure buildup in a hydraulic circuit. The accumulator consists of a piston spring and sealing rings. Fluid pressure is applied to the piston, compressing the spring. Line pressure buildup is delayed until the piston is completely sealed in its bore. Some accumulators use multiple diameters with multiple fluid ports, giving different rates of accumulation (time), depending upon which port is pressurized.

F. Automatic transmissions often use actuated valves. Actuated valves use external mechanical, electrical, or pneumatic force to meter fluid flow or to turn flow off and on.

1. In mechanically actuated valves, a mechanical linkage or mechanism is used to move or position the spool valve in order to meter or switch the direction of fluid flow.

2. In vacuum actuated valves, a vacuum source (usually an intake manifold) modulates the position of a diaphragm servo. The servo is connected to a spool valve that meters fluid flow on the basis of manifold vacuum.

3. In an electrically actuated valve, an electrical solenoid is used to move a spool or poppet valve either to permit or prohibit fluid flow. Metering is not possible because the solenoid has only two operating modes--off and on.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

AUTOMATIC TRANSMISSION CONTROL DEVICES

Instructions: Do the following tasks and answer the following questions. Write all responses on this sheet.

1. Name three types of rotary pumps used in automatic transmissions.

2. Describe the purpose of the pressure regulating valve.

3. Describe the purpose of the pressure relief valve.

4. What determines the level of pressure at which the relief valve will open?

5. What purpose does auxiliary pressure serve in the pressure regulation valve?

6. Describe the function of the dual-seat ball check valve.

7. What determines the output pressure of the automatic transmission governor?

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

AUTOMATIC TRANSMISSION CONTROL DEVICES

(ANSWER SHEET)

1. Gear pump, lobe pump, vane pump

2. The pressure regulating valve regulates transmission fluid pressure according to the operating mode of the transmission.

3. The pressure relief valve is a spring-loaded device that is forced open by excessive mainline pressure. When the valve is forced open, it directs the excessive pump output directly back to the pump. The size of the valve opening and the tension on the check spring determine the relief pressure point.

4. To achieve an output pressure based upon spring tension plus auxiliary PSI/area versus reaction pressure

5. The dual-seat ball check allows fluid flow from two different sources to act on a single outlet in the automatic transmission. The ball check is used to direct fluid flow down the outlet.

6. The rpm of transmission output shaft (vehicle drive shaft)

7. The accumulator is used to absorb hydraulic shock or to delay pressure buildup in a hydraulic circuit.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

UNIT II: HYDRAULIC CONTROL SYSTEMS

LESSON 3: FUNDAMENTALS OF HYDRAULIC CONTROL

I. Automatic transmission fluid pressure control

   A. The fluid supply system includes the pump, the pressure regulator valve, the pressure boost valve, the pressure relief valve, the converter control, the cooler control valves, and the lubrication ports. All of these devices work together to accomplish the tasks listed below.

      1. Maintain mainline pressure at a specified level during a specific operating mode.

      2. Maintain a fluid supply to the torque converter.

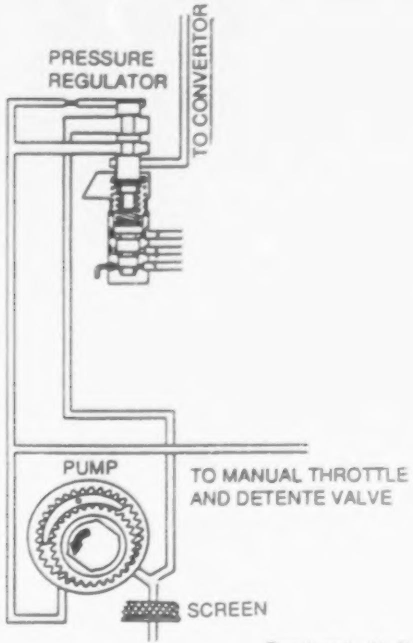
      3. Maintain fluid supply to the cooler.

      4. Supply and circulate lubrication for mechanical components of the transmission.

      5. Supply fluid to the hydraulic control system to control the shifting of the transmission mechanical components.

B. Control of mainline pressure

1. The pressure regulator valve senses pump output pressure and maintains the pressure at a predetermined level. The amount of fluid resistance (pressure build-up) in a hydraulic system is determined by the number of hydraulic units energized, the fluid leakage of internal components, and the rotational speed of internal components. The pressure regulator valve is a balanced valve, meaning that pump output is on the reaction area of the valve and is balanced against spring tension. This arrangement reduces valve flutter and makes the valve more sensitive to mainline pressure changes. The discharge or exhaust from the regulation valve is dumped either into the pump or into the suction side of the pump.



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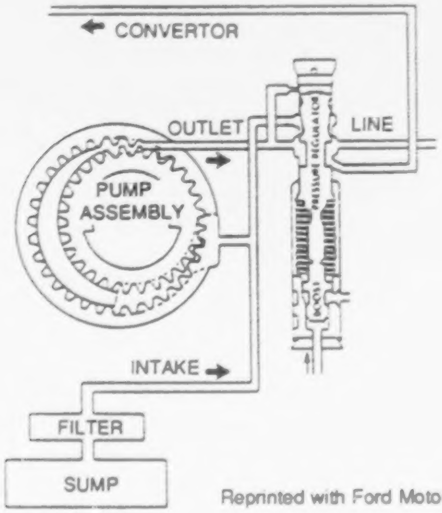
2. In addition to the pressure regulation valve, a boost valve is sometimes used to alter the mainline pressure during specific operating modes. Reverse and throttle pressure are applied to the back of the regulator valve, thus counteracting the spring tension on the valve and raising mainline pressure to a higher level.

C. In an automatic transmission, the converter is supplied with fluid pressure from one of two systems: either a pressure regulated system or a control valve system.

1. In the pressure regulated system, mainline oil pressure is supplied directly to the converter and is subject to the same pressure changes as the mainline. In some cases an increase in boost pressure can even restrict fluid flow to the converter for a short time in order to increase mainline pressure for reverse or passing gears. When the engine is turned off, the drop in pump output allows the regulator valve spring to close the converter port, thus preventing the torque converter from draining back to the pump.



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2. If a control valve is used, mainline oil pressure is transferred to a converter control valve and then passed onto the torque converter. Pressure in the torque converter builds and pushes on the back (reaction) area of the control valve, counteracting the spring tension and allowing the control valve to block one of the converter passages (but leaving open the passage with the flow-restricting orifice). Converter pressure is a result of converter (reaction) outlet pressure versus the pressure drop across the orifice. When the engine is turned off, the pressure regulator valve blocks converter drain back.

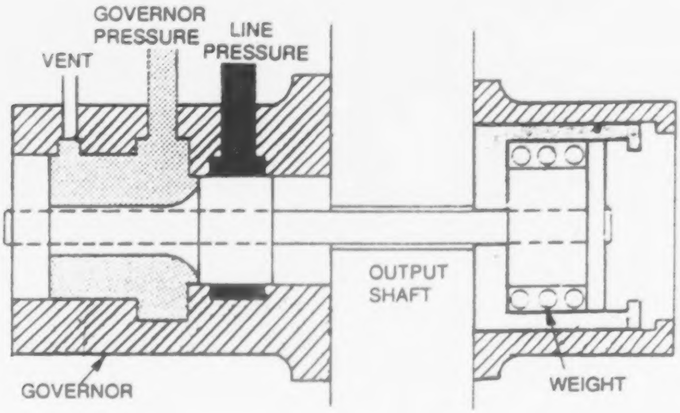
D. The cooler in an automatic transmission receives fluid pressure from the torque converter. The filled converter continuously allows a portion of its fluid to flow into the cooler circuit. The rate of fluid flow to the converter depends upon either a control valve or a combination of the control valve and pressure regulator valve. Occasionally an additional check valve is used with the converter and cooler supply to limit converter drain back.

E. The lubrication system in an automatic transmission is usually a part of the cooler circuit. A pressure orifice is used to limit the amount of oil flowing to the lubrication system. Drilled passages carry the fluid to gears, bearings, thrust washers, and friction elements.

F. The mainline pressure system (hydraulic control system) provides fluid at regulated pressure to the following components: the friction apply components, the control valve, the converter, and the cooler. Relay valves are used in friction apply components to determine when a gear set will be energized or de-energized. Actuated valves can be used to modify the relay valves' activity by overriding or canceling the action of the relay valves. Mainline pressure is transferred to and metered by the actuated valve.

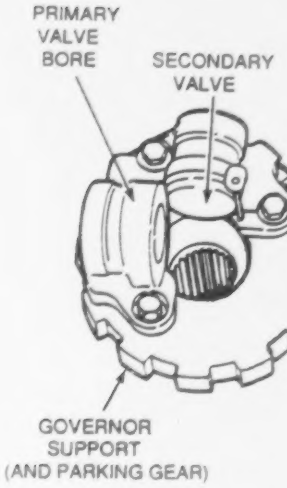
II. An engine creates its maximum torque within a narrow rpm band; therefore, the transmission has to determine the gear set combination that will apply engine power most efficiently at specific vehicle speeds. A shift control system selects a gear set combination that is appropriate for the engine rpm and load. The shift control system makes its selection according to transmission rpm in relation to engine load.

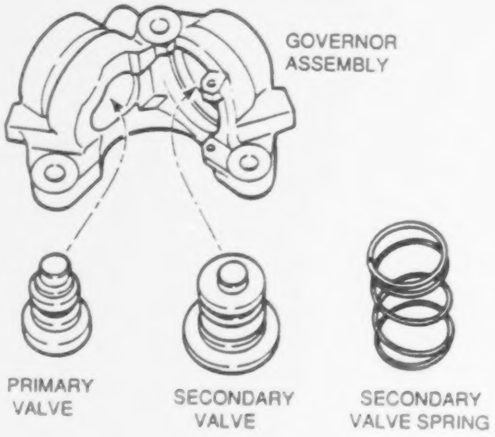
A. The governor (centrifugal) uses a set of mechanical flyweights to position a spool valve in a passageway. Mainline hydraulic pressure is exerted against the valve inlet and is metered by the size of the opening to the spool valve based upon the position of the flyweights. The higher the rpm, the greater the opening, and the higher the governor pressure. This governor pressure signals the time for gear changes because it is related to the speed of the turning wheels. Governors can be either case mounted or shaft mounted.



1. A case-mounted governor is driven by the output shaft. Usually the governor is mounted at a 90-degree angle to the shaft. Unequal flyweights may be used to allow for a wider range of governor operation.

2. The shaft-mounted governor is a part of the output shaft and, therefore, rotates with the shaft. A set of oil distribution rings provide a sealing system between the stationary case and the rotating governor. The same flyweight principle applies to its operation. Like the case-mounted governor, unequal flyweights may be used to allow for a wider range of governor operation.





B. Automatic transmissions use two types of engine load monitoring devices: the intake manifold vacuum sensors and the engine throttle valves. The vacuum sensors and engine throttle valves can interrupt or override the governor's signal for shifting.

1. The intake manifold vacuum sensor (modulator valve)

a. The intake manifold vacuum sensor is a vacuum servo, which is connected to the modulator valve. The intake manifold vacuum sensor is spring loaded and is closed by the return spring inside the servo. When the engine is turned on, intake manifold vacuum is applied to the diaphragm, thus counteracting the return spring. As the diaphragm is pulled back, line pressure is blocked from the modulator port. Intake vacuum decreases when the engine throttle is open, thus causing the diaphragm return spring to reopen the modulator valve. Once open, the modulator valve meters fluid to the shift valves, thus determining when they act upon the gear sets.

b. A governor port allows governor pressure to override modulator pressure, thus making upshift possible at a higher rpm. (The governor pressure port also allows upshift in case the vacuum line becomes disconnected.) Modulator pressure may also be used to provide boost pressure on the pressure regulating valve.

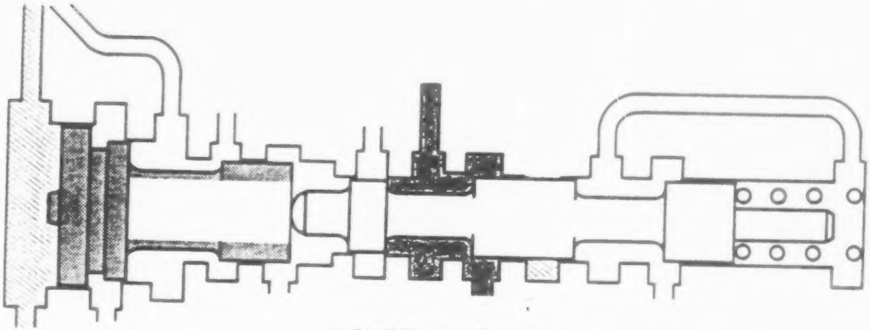
(NOTE: It is important to remember that modulator pressure modifies the governor's signal and thus controls the shifting of the transmission.)

2. Engine throttle valve

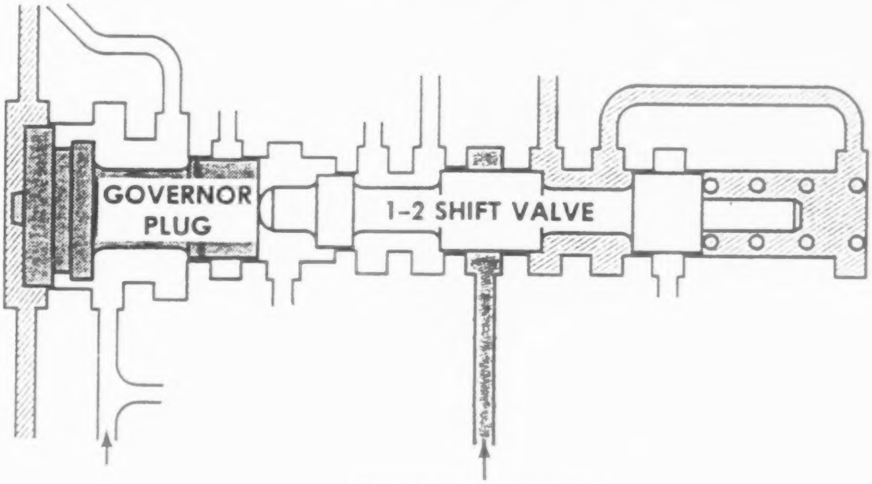
   a. The engine throttle valve works in conjunction with the detent (kickdown) valve. The kickdown and engine throttle valves are connected to the throttle by a linkage or cable. The valves move in relation to throttle movement. When the throttle is closed, the throttle valve blocks pressure. When the throttle is opened, the linkage transfers the throttle motion to a bell crank, which applies pressure to the spring on the throttle valve. The spring positions the valve to allow a measured fluid flow to the shift valve.

   b. Throttle pressure modifies the governor's shift signal. If the throttle is pressed all the way down (wide open throttle), the kickdown valve forces the engine throttle valve into a wide-open condition, causing forced downshift of the gear sets. Again, governor pressure can regain shift control if the rpm of the output shaft is high enough.

C. In an automatic transmission, shift valves are a type of relay valve. Shift valves change their position in order to direct transmission line pressure to the appropriate gear sets. The position of the shift valves is determined by the following: level of the governor pressure versus the reaction forces of spring tension; modulator pressure; throttle pressure; or any combination of these three pressures. When the governor pressure overcomes the reaction forces applied to the valve, the shift valve relays mainline pressure to the gear set apply devices, thus causing the transmission to upshift.



HIGH GOVERNOR PRESSURE



LOW GOVERNOR PRESSURE

D. The manual valve is used to select the operating mode of the automatic transmission. Typical operating modes are: park, reverse, neutral, automatic drive, manual intermediate, and manual low.

1. When the transmission is shifted into park, the manual valve cuts off hydraulic fluid pressure from all hydraulic control units except the pressure regulator, the converter, and the cooler. In addition, the manual valve linkage engages a locking pawl on the output shaft, thus preventing the shaft from rotating.

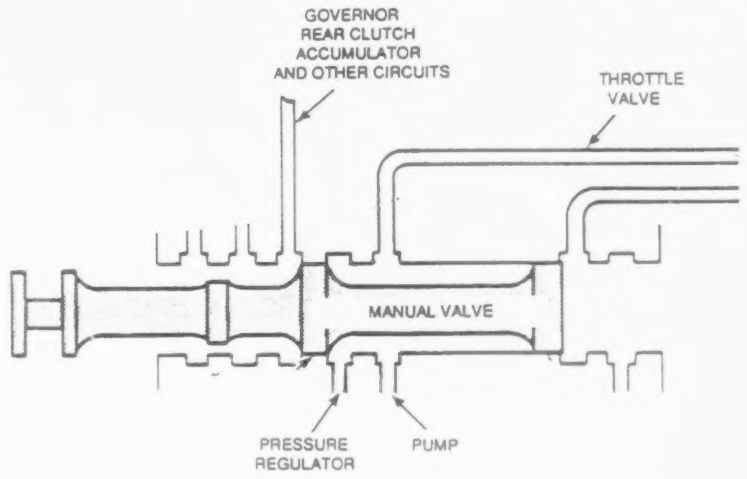
2. When the transmission is in reverse, the manual valve allows fluid pressure to be applied only to the reverse gear units, the pressure regulator pressure boost, the converter, and the cooler. When the transmission is in reverse, the reverse apply units require greater holding force. This increase in holding force is made available by an increase in mainline pressure provided by the boost valve.

3. When the transmission is in neutral, transmission components function just as they do in park, except that the park pawl is disengaged and the output shaft is allowed to freewheel.

4. When the transmission is in drive, the manual valve allows all hydraulic control circuits to receive fluid pressure. Automatic upshift is allowed with the exception of reverse, manual intermediate, and manual low.

5. When the transmission is in manual intermediate, the manual valve allows automatic upshift from low to intermediate. However, the valve will not allow upshift from intermediate to drive. If the vehicle is in drive at the time the manual valve is moved to intermediate, the transmission will downshift into intermediate.

6. When the transmission is in manual low, the manual valve denies fluid pressure to the low intermediate and drive components.



E. Some late-model vehicles have automatic transmission systems that use electrical shift valves. These shift valves are controlled by a microprocessor. In these transmission systems, electrical solenoid valves direct mainline pressure to the appropriate gear sets. A microprocessor compares input signals from the sensors that measure engine load, output rpm, and throttle opening. The microprocessor generates an output signal that then energizes the appropriate control circuits.

III. Operating principles of a transmission fluid control unit (valve body)

(NOTE: The arrangement of automatic transmission components and the principles by which they operate vary from manufacturer to manufacturer. Also keep in mind that the below description of the operating principles is based on a three-speed transmission using two clutches, two band assemblies, and a throttle valve assembly.)

A. Operation of the automatic transmission in park position

1. In park, the transmission oil pump pulls fluid from the reservoir and discharges it to the pressure relief valve, the pressure regulating valve, and the manual valve. The manual valve directs pump discharge behind the pressure regulating valve, which acts as a hydraulic damper. The pressure relief valve is seated.

2. The pressure regulating valve meters line pressure and directs it to the converter control valve. The converter control valve creates a pressure drop and regulates the rate of fluid flow to the lubrication circuits, the torque converter, and the cooler.

B. Operation of the automatic transmission in automatic low gear

1. In automatic drive first gear, the manual valve is positioned to allow line pressure to go to the components listed below.

   a. The governor

   b. Throttle valve

   c. 1-2 shift accumulator

   d. The rear clutch (low gear)

   e. 1-2 shift valve

   f. Torque converter and cooler

2. As the throttle is pressed during automatic drive low gear, more mainline pressure is allowed through the throttle valve, causing the throttle to apply more pressure to the components listed below.

   a. The pressure regulating valve (The higher throttle pressure rises, the more mainline pressure that will be exerted on the 2-3 shift and shift control valves.)

   b. The 1-2 shift valve and the 1-2 shift control valve (The higher the throttle pressure, the greater the governor signal required to initiate a shift.)

   c. The 2-3 shift and shift control valves are the same as the 1-2 shift valve except that the throttle pressure is regulated by a limit valve on 2-3 shift. The limit valve allows the governor pressure to override throttle pressure at a high rpm.

3. During automatic drive first gear, the governor begins to rotate; as a result, it opens. The governor thereby meters and directs mainline pressure to the components listed below.

    a. The front of the 1-2 shift valve (Once at the 1-2 shift valve, the pressure begins to overcome the resistance of the throttle and spring pressures.)

    b. The front of the 2-3 shift valve (Once at the 2-3 shift valve, the pressure begins to overcome the much higher resistance of the throttle and spring pressures.)

    c. The limit valve, which controls throttle pressure to the 2-3 shift valve

    d. The shuttle valve, which charges the 1-2 accumulator upon upshift and (along with the governor) puts pressure on the 1-2 shift valve to help initiate 1-2 shift

C. Operation of the automatic transmission during the 1-2 shift sequence

1. As the vehicle begins to move in low gear, the automatic transmission soon requires a gear change. The following shift demands, however, must be met before the gear change will occur.

    a. Governor pressure must be high enough to overcome the throttle pressure and spring tension on the 1-2 shift valve.

    b. The shuttle and 1-2 control valve must counter governor pressure to allow 1-2 shift valve movement at the proper moment.

2. When the shift takes place, the components function in the manner described below.

    a. The governor pressure forces open the 1-2 shift valve, and, as a result, the intermediate circuits receive mainline pressure.

    b. The 1-2 accumulator begins to charge, buffering line pressure buildup.

    c. The front band makes contact with the drum.

    d. Rear clutch pressure is maintained. The band is locked onto the drum and the transmission is forced into intermediate (2nd) drive.

D. Operation of the automatic transmission during the 2-3 shift

1. After travelling in the second shift position, the transmission is soon required to shift to the third position. In order for the 2-3 shift sequence to occur, the following shift demands must be met.

    a. Governor pressure must be sufficiently high to move the 2-3 shift valve enough so that mainline pressure can pass through it.

   b. The governor pressure must be high enough to overcome the throttle pressure.

2. As the 2-3 shift valve opens and supplies mainline pressure to the 2-3 circuit, the below events occur simultaneously.

   a. The front clutch begins to pressurize.

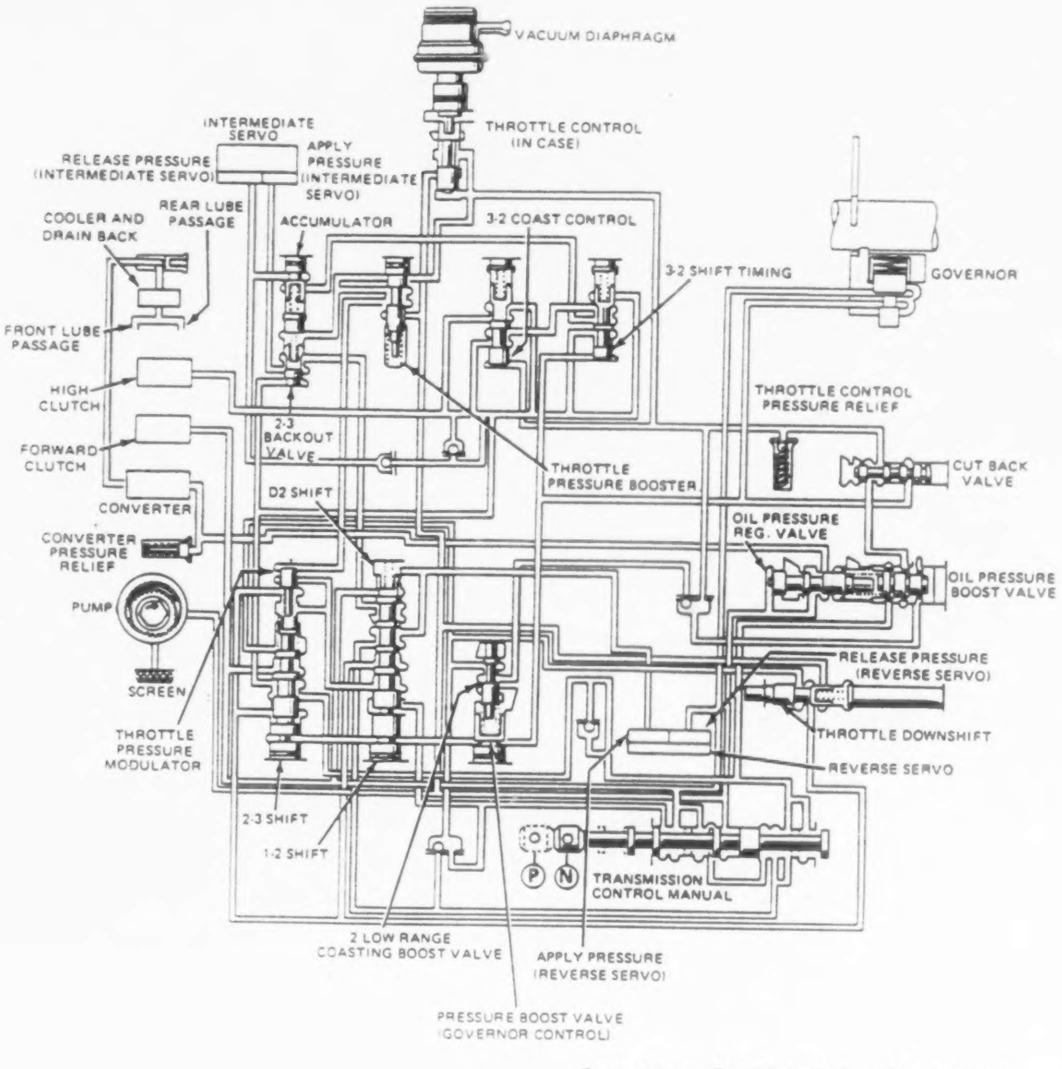
   b. The 2-3 shift pressure is applied to the non-apply side of the front band servo. The apply side of the front band servo has a large surface area; therefore, the apply side will disengage the front band at a rate equal to the apply of the front clutch. Mainline pressure acts as an accumulator on the apply side of the servo, buffering the application of the front clutch.

E. Operation of the automatic transmission during full throttle kickdown (detent)

1. When the driver pushes the accelerator completely to the floor, the kickdown linkage is engaged and forces the kickdown valve all the way in.

2. When completely in, the kickdown valve applies mainline oil pressure behind the 2-3 shift valve, thus pushing the valve against governor pressure and removing fluid pressure from the front clutch and front band. The transmission is then in low. As governor pressure begins to increase as a result of greater engine rpm output, it forces the limit valve closed, allowing for normal upshift as engine torque peaks.

F. When the manual valve is placed in reverse, mainline pressure is ported to the front clutch, rear servo, and the pressure regulator boost. All the other circuits are de-energized with the exception of the torque converter and the cooler.


VACUUM DIAPHRAGM
INTERMEDIATE SERVO
THROTTLE CONTROL (IN CASE)
RELEASE PRESSURE (INTERMEDIATE SERVO)
APPLY PRESSURE (INTERMEDIATE SERVO)
COOLER AND DRAIN BACK
REAR LUBE PASSAGE
ACCUMULATOR
3-2 COAST CONTROL
3-2 SHIFT TIMING
GOVERNOR
FRONT LUBE PASSAGE
HIGH CLUTCH
THROTTLE CONTROL PRESSURE RELIEF
2-3 BACKOUT VALVE
FORWARD CLUTCH
THROTTLE PRESSURE BOOSTER
CUT BACK VALVE
CONVERTER
D2 SHIFT
OIL PRESSURE REG. VALVE
CONVERTER PRESSURE RELIEF
OIL PRESSURE BOOST VALVE
PUMP
SCREEN
RELEASE PRESSURE (REVERSE SERVO)
THROTTLE PRESSURE MODULATOR
THROTTLE DOWNSHIFT
REVERSE SERVO
2-3 SHIFT
1-2 SHIFT
P
N
TRANSMISSION CONTROL MANUAL
2 LOW RANGE COASTING BOOST VALVE
APPLY PRESSURE (REVERSE SERVO)
PRESSURE BOOST VALVE (GOVERNOR CONTROL)

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MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

UNIT II: HYDRAULIC CONTROL SYSTEMS

LESSON 4: HYDRAULIC SEALS AND FLUID

I. Automatic transmission fluid

A. Automatic transmission fluid serves all the functions listed below.

1. Acts as a torque transfer medium between the torque converter pump and the turbine.

2. Absorbs the heat generated by friction and hydraulic action and transports the heat to the cooler.

3. Acts as a control fluid in the valve body and quickly transfers power for controlling components.

4. Acts as a lubricant for transmission components.

B. Automatic transmission fluid consists of petroleum mineral oil and a blend of additives which enhance the oil's performance. Listed below are various characteristics of transmission fluid.

1. Fluid viscosity refers to the thickness of automatic transmission fluid. A low viscosity rating indicates a thin fluid and a high viscosity indicates a thick fluid. The automatic transmission fluid must be thin enough to flow freely at low temperatures yet not become too thin at high temperatures.

2. The viscosity index refers to the change in viscosity of a transmission fluid as it passes through a typical operating temperature range. For example, a fluid that shows a small change in viscosity at all points of the operating temperature range is said to have a high viscosity index.

3. Lubricity is a measure of how well the fluid will prevent wear between moving parts. A high level of lubricity is required of automatic transmission fluid.

4. Any fluid that is churned by mechanical components will tend to foam (form air bubbles). Anti-foaming additives help to reduce the tendency of the fluid to foam.

5. Automatic transmission fluid can undergo oxidation, which is a chemical breakdown resulting from external contamination or exposure to high temperatures. If transmission fluid oxidizes, it can cause transmission components to rust or become corroded. Chemical inhibitors are added to transmission fluid to reduce the effects of oxidation.

C. Each blend of automatic transmission fluid is a specially formulated combination of additives and base oil. Each vehicle manufacturer specifies the exact fluid properties required of a transmission fluid. Mixing one type of fluid with another can alter the properties of both fluids, making them unfit for the vehicle in which they are to be used. To prevent accidental mixing, each type of transmission fluid has a specific name. Some of these fluids are listed below.

1. Ford Motor Company has specified F or FA as the proper type of transmission fluid for most Ford vehicles. Type F or FA has a low lubricity and a high friction coefficient at high fluid temperatures.

2. In 1968 General Motors introduced Dexron, a transmission fluid with a unique friction modifier additive. GM recommended the use of Dexron until 1971 when they developed Dexron II.

3. In 1971 GM introduced Dexron II. Dexron II had the same basic qualities as Dexron but used an oil additive to reduce friction. GM recommended Dexron II until the early 1980's when they introduced Dexron IID.

4. In the early 1980's GM introduced Dexron IID, which is sometimes called the universal transmission fluid. Dexron IID can be used in most transmissions built after 1976. (However, some change in shift feel or fluid color may occur when adding Dexron IID to a transmission not built by GM.) If at all possible, the technician should only use a fluid specifically recommended by the vehicle manufacturer.

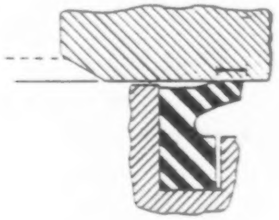
5. Ford Motor Company produced a few transmissions that called for CJ fluid. Dexron IID is a suitable substitute for CJ transmission fluid.

6. Most import vehicles use type F fluid, but there are some exceptions. Consult an appropriate service manual to determine precisely which fluid is to be used.

II. Seals prevent automatic transmission components from leaking both internally and externally. Automatic transmission seals may be made from synthetic rubber, cast iron, aluminum, or teflon. The seals can be used on moving (dynamic) or non-moving (static) components.

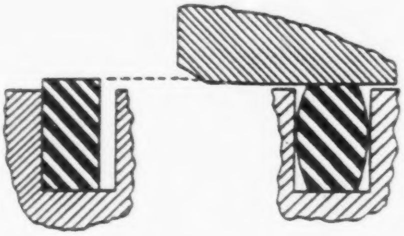
A. In most automatic transmissions, lip seals, o-ring seals, and square cut seals are made from synthetic rubber.

1. The lip seal is a molded seal usually designed to prevent leakage in only one direction. The lip of the seal is formed at a diameter larger than the bore in which it is installed. When installed, the lip is compressed inward by the bore. As fluid pressure is applied to the inside of the lip, it is flared outward and is sealed tightly against the bore.



2. Another style of lip seal, also made of synthetic rubber, uses a garland spring to force the lip against the sealing surface. Sometimes a secondary lip is used on the outside of the sealing area to guard against dirt and grit.

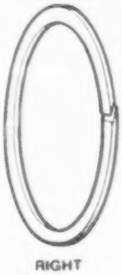
3. The square cut o-ring has a square cross section, which is cut from an extruded synthetic sleeve--hence its name "square cut." The seal diameter is larger than the bore, and when installed, it is slightly compressed by the bore's chamfered edge. Because the o-ring is under both inward and outward pressure, it creates a fluid-tight seal in both directions.



4. The o-ring has a round cross section, which is squeezed during installation to achieve a seal. The o-ring seal tends to roll in the seal groove and is, therefore, used only on static components.

B. Metal seal rings are similar to the compression rings used on engine pistons. Metal seal rings are designed to leak a small amount of fluid, which is used to lubricate internal components. Cut from cast iron, the rings may have small locking tangs, which serve both to limit expansion of the ring upon installation and to retard fluid leakage through the ring joint. Hydraulic pressure pushes the ring over in its groove. The ring's close tolerances allow it to be sealed to the groove and its bore wall mating surface.

C. Teflon ring seals function in the same manner as metal rings. The teflon seal usually consists of a single teflon ring that is stretched and placed over the groove. Some teflon seals, however, are split; these seals use an angled joint to seal the ends.



III. Seal inspection and installation

A. Seals and their sealing surfaces must be inspected carefully in order to diagnose failed transmission components correctly and to prevent future component failure. Listed below are procedures for inspecting seals. These procedures will apply to most transmissions.

1. After failure, synthetic lip seals should be inspected for the problems listed below.

    a. Roughness or grooving of the seal contact area

    b. Incorrect seal diameter

    c. Rotating or rolling of the seals

    d. Excessive clearance on support bushings allowing excessive shaft movement

    e. Hardening, sludge, or other contamination

    f. Misalignment of parts

    (NOTE: On seals using a metal retainer, check for signs of leakage around the metal retainer.)

2. Because of the high level of friction that exists between the metal sealing rings and the bore wall, metal sealing rings are vulnerable to excessive wear. Check sealing rings and bores for the problems listed below.

    a. Broken ring tangs

    b. Excessive ring end gap on butt rings

    c. Ring side to side clearance

    d. Unusual ring groove wear patterns

    e. Scoring of the bore wall

3. Teflon seals are easily scratched. Also, foreign material can easily become embedded in teflon seals. Scratching and embedded material can result in failure of the seal or excessive wear of the bore wall. Check teflon seals for the items listed below.

    a. Abraded seal surface

    b. Lack of seal squareness from overheating

    c. Misaligned or missing seal angle

    d. Rough or scored bore wall

B. Procedures for installing seals

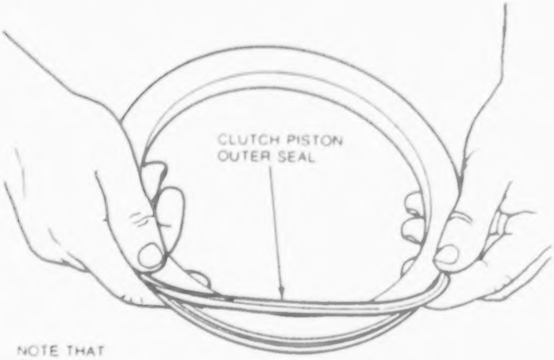
(NOTE: The below installation procedures are general. Procedures may vary from vehicle to vehicle. Refer to the proper service manual for specific procedures for the vehicle to be serviced.)

1. Procedures for installing a piston lip seal

    (NOTE: The piston lip seal is used on clutch assemblies. The piston lip seal rests in a machined groove and moves with the piston along the bore. This seal is most commonly used on reciprocating pistons.)

    (NOTE: The lip of the new seal must be placed in the proper direction. When removing the old seal, be sure to determine and record, if necessary, the correct direction of the fluid pressure.)

a. Gently stretch the seal over the piston, engaging the seal in the correct groove. Next, lubricate the seal with assembly fluid.



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b. Using a .010 feeler gauge or a piano wire tool, work the seal lip into the bore. (Use very light hand pressure.) When the piston falls into the bore, rotate it slightly from side to side. The seal should move freely, thus indicating that the lip is not folded back. If the piston is jammed, remove it and inspect the seal lip for damage. Replace as needed, using the same installation procedures.

2. Procedures for installing a shaft seal

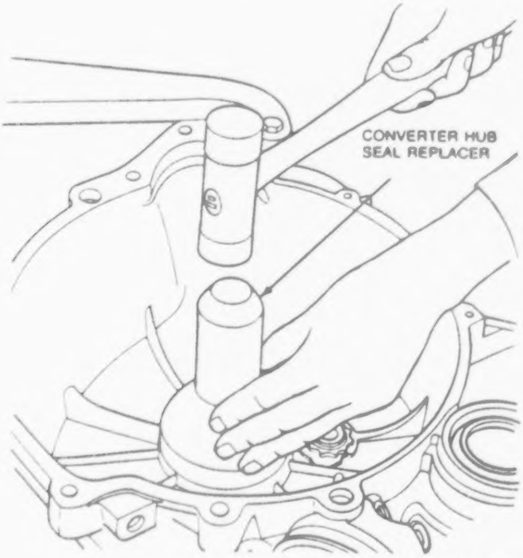
(NOTE: The shaft seal is usually retained by the interference fit between the seal retainer and the seal bore. During installation, the seal must be driven in with an appropriate driver.)

a. Drive out the old seal and clean the seal bore.

b. Spread a very light coat of RTV on the seal outer retainer.

c. Select the proper driver and drive the seal into the correct position. Lubricate the lip with assembly fluid.

(NOTE: If the wrong driver is used, the seal retainer and subsequently the lip seal may be deformed.)



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3. Procedures for installing a square-cut seal

(NOTE: The chambered edges on the square-cut seal bore are used to compress the seal upon installation.)

a. Install the new seal by stretching it gently over the piston and placing it in the correct groove. Avoid rolling in the seal; the groove edges might score or cut the seal surface.

b. Lubricate the seal with assembly fluid, align the piston in the bore, and push it in firmly. Hand pressure should be sufficient to compress the rings in their grooves. If excessive pressure is required, remove the piston and inspect for seal damage.

4. Procedures for installing an angle-cut teflon seal

(NOTE: An angle-cut teflon seal uses a chambered edge to collapse the seal into its proper position. Care must be taken to ensure proper positioning of the angled cut or the seal will be twisted and scarred during installation.)

a. Install the teflon seal into the correct groove.

b. Butt the angled surfaces together.

c. Coat the seal with assembly fluid or petroleum jelly. Provide a means of temporarily holding the seal in place.

d. Gently slide the seal into the bore, slightly wiggling it from side to side.

5. Procedures for installing a one-piece teflon ring seal

(NOTE: Special installation tools are required for installation of teflon rings. Do not attempt installation without the appropriate tools.)

a. Slide installation sleeve over the seal groove.

b. Lubricate seal and slide it over the sleeve.

c. Using the seal installer, push the teflon ring up to the edge of the sleeve. Check for proper alignment of the edge of the sleeve with the seal groove.

d. Push the seal into the groove with the seal installer.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

TRANSMISSION FLUID AND TRANSMISSION SEALS

Instructions: **Do the following tasks and answer the following questions. Write all responses on this sheet.**

1. Define the terms listed below.

   Lubricity

   Oxidation resistance

   Viscosity

   Viscosity index

2. What problems could arise from mixing different types of transmission fluids?

3. What causes a lip seal to seal against the bore wall?

4. Why was the square cut seal given its name?

5. Why are o-rings used mostly on static sealing components?

6. What purpose do the tangs serve on the metal sealing ring?

7. How is the fluid pressure sealed by the metal ring seal?

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

TRANSMISSION FLUID AND TRANSMISSION SEALS

(ANSWER SHEET)

1. Lubricity is a measure of how well the fluid will prevent wear between moving parts. A high level of lubricity is required of automatic transmission fluid.

   Oxidation resistance is the ability of transmission fluid to resist oxidation and its corrosive effects.

   Viscosity refers to the thickness of automatic transmission fluid. A low viscosity rating indicates a thin fluid; a high viscosity indicates a thick fluid. The automatic transmission fluid must be thin enough to flow freely at low temperatures yet not to become too thin at high temperatures.

   The viscosity index refers to a transmission fluid's change in viscosity as the fluid passes through a typical operating temperature range. For example, a fluid that shows a small change in viscosity at all points of the operating temperature range is said to have a high viscosity index.

2. Mixing one type of fluid with another can alter the properties of both fluids, making them unfit for the vehicle in which they are to be used.

3. The lip of the seal is formed at a diameter larger than the bore in which it is installed. When installed, the lip is compressed inward by the bore.

4. The square cut o-ring has a square cross section, which is cut from an extruded synthetic sleeve--hence its name "square cut."

5. The o-ring seal tends to roll in the seal groove and is, therefore, used only on static components.

6. The tangs serve both to limit expansion of the ring upon installation and to retard fluid leakage through the ring joint.

7. Hydraulic pressure pushes the ring over in its groove. The ring's close tolerances allow it to be sealed to the groove and to its bore wall mating surface.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

UNIT II: HYDRAULIC CONTROL SYSTEMS

UNIT II TEST

SECTION A. **Match the terms below with their appropriate definitions.**

____ 1. A component that forces downshift as a result of rapid wide open throttle (W.O.T.) acceleration

____ 2. A measure of a fluid's ability to reduce friction between moving members

____ 3. A component that varies a transmission's shift point on the basis of engine vacuum

____ 4. A measure of a fluid's thickness at a given temperature

____ 5. A device which controls the transmissions's shift point on the basis of throttle opening

____ 6. The major fluid supply circuit for transmission components

____ 7. A narrow opening in a fluid passage used to regulate fluid flow

a. boost valve
b. check valve
c. detent valve
d. lubricity
e. mainline pressure
ab. modulator valve
ac. pressure orifice
ad. throttle valve
ae. viscosity

SECTION B. **Read the statements below. Place a T or F in the blank beside each statement to indicate whether it is true or false.**

____ 8. In an automatic transmission, the positive displacement pump will move a predictable amount of fluid at an established engine rpm.

____ 9. An accumulator reduces the harsh shift effects of an automatic transmission.

____ 10. A case mounted governor is driven by the input shaft.

____ 11. According to Pascal's law, fluid cannot be compressed.

____ 12. Spool valves can be either square or rectangular in shape.

____ 13. According to Pascal's law, a mechanical advantage cannot be achieved with a hydraulic system.

____ 14. According to Pascal's law, motion can be transmitted through fluid.

____ 15. As fluid moves through an orifice, the speed and pressure of the fluid is reduced.

____ 16. Pumps work to create a pressure difference in a hydraulic circuit.

____ 17. In automatic transmissions, poppet valves are used to determine the direction, rate, and timing of fluid flow.

____ 18. An actuator transforms fluid pressure into mechanical force.

____ 19. Almost all basic hydraulic systems use some sort of control valve.

____ 20. Most automatic transmissions will use either a gear or lobe pump.

____ 21. A poppet valve uses a round disc or tapered needle valve to close an opening.

____ 22. Some check valves use two balls.

____ 23. Governors are activated by centrifugal force.

____ 24. Electrically actuated valves are used for metering purposes.

____ 25. The torque converter produces hydraulic pressure.

____ 26. In most automatic transmissions, the cooler draws oil directly from the reservoir.

____ 27. Engine torque is highest in a wide rpm band.

____ 28. The throttle valve can modify shift timing.

____ 29. New transmission designs use electronic controls to time the shift points.

____ 30. In automatic transmissions, a garland seal prevents leakage in only one direction.

____ 31. In automatic transmissions, a garland seal allows a small amount of leakage for lubrication of other components.

____ 32. In automatic transmissions, synthetic seals should be checked for grooving.

____ 33. In automatic transmissions, metal sealing rings should be checked for broken ring tangs.

____ 34. In automatic transmissions, o-ring seals are usually used on dynamic components.

SECTION C. **Select the best answer from the five choices listed.**

____ 35. Dexron IID is sometimes called the

a. American fluid.
b. European fluid.
c. universal fluid.
d. import fluid.
e. high-tech fluid.

____ 36. Seals used in automatic transmissions can be made from

a. synthetic rubber.
b. cast iron.
c. aluminum.
d. teflon.
e. all of the above.

____ 37. When installing a lip seal on a piston, a technician should use

a. a torque wrench and a press.
b. a press and a feeler gauge.
c. a feeler gauge and fine wire.
d. a soft mallet and a punch.
e. none of the above.

____ 38. Oil seals on extension housings are usually held in place by

a. a garland spring.
b. lip pressure.
c. the motor mount.
d. an interference fit.
e. none of the above.

(NOTE: The student must obtain a minimum score of _____ on the Unit II Test in order to receive an evaluation for any competencies in the Automatic Transmission/Transaxle Module.)

ANSWERS TO UNIT II TEST

1.	c
2.	d
3.	ab
4.	ae
5.	ad
6.	e
7.	ac
8.	t
9.	t
10.	f
11.	t
12.	f
13.	f
14.	t
15.	f
16.	t
17.	f
18.	t
19.	t
20.	t
21.	t
22.	f
23.	t
24.	f
25.	f
26.	f
27.	f
28.	t
29.	t
30.	t
31.	f
32.	f
33.	t
34.	f
35.	c
36.	e
37.	d
38.	d

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

UNIT III: TRANSMISSION/TRANSAXLE DIAGNOSIS

UNIT OBJECTIVE

After completing this unit, the student should be able to evaluate and diagnose automatic transmission/transaxle problems and recommend appropriate repairs. The student will demonstrate mastery of the material by achieving a score of ____ on the unit test and successfully performing specific tasks.

SPECIFIC OBJECTIVES

After completing the lessons in this unit, the student should be able to:

Lesson 1. I. Identify terms and definitions associated with the evaluation and diagnosis of transmission problems (Competency Ee1, Unit III Test).

II. Identify important diagnostic information included in driver complaints (Competency Ee1, Unit III Test).

III. Identify the procedures for road testing automatic transmissions (Competency Ee1, Unit III Test).

IV. Identify the procedures for diagnosing transmission/transaxle noise and vibration problems (Competency Ee1, Unit III Test).

V. Identify the procedures for diagnosing and repairing fluid leakage and poor fluid condition (Competency Ee1, Unit III Test).

VI. Demonstrate the ability to:

- a. Road test an automatic transmission (Competency Ee1, JS1-L1-UIII).
- b. Diagnose noise and vibration problems (Competency Ee1, JS2-L1-UIII).
- c. Diagnose transmission fluid leakage and poor fluid condition (Competency Ee1, JS3-L1-UIII).

Lesson 2. I. Identify the various tests to be performed on automatic transmissions after they have been road tested (Competency Ee1, Unit III Test).

II. Identify the theory for performing a torque converter stall test (Competency Ee1, Unit III Test).

III. Identify the purpose and the basic principles of hydraulic control pressure tests (Competency Ee1, Unit III Test).

IV. Identify the procedures for performing a hydraulic control pressure test (Competency Ee1, Unit III Test).

V. Identify the procedures for performing a torque converter stall test (Competency Ee1, Unit III Test).

VI. Identify the procedures for testing lockup converters (Competency Ee1, Unit III Test).

VII. Demonstrate the ability to:

  a. Perform an automatic transmission stall test (Competency Ee1, JS1-L2-UIII).

  b. Perform a hydraulic control pressure test (Competency Ee1, JS2-L2-UIII).

  c. Perform a lockup torque converter test (Competency Ee1, JS3-L2-UIII).

ASE TASKS COVERED IN THIS UNIT

I. The job sheets in this unit cover ASE tasks B001-B006.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

UNIT III: TRANSMISSION/TRANSAXLE DIAGNOSIS

CONTENTS OF THIS UNIT

A. Objective sheet

B. References

C. Notes to the instructor

D. Lesson plans

    1. Lesson 1: EVALUATION AND DIAGNOSIS OF TRANSMISSION PROBLEMS

        a. Information outline

        b. Assignment sheets

            AS1-L1-UIII: Diagnosing a Transmission/Transaxle
            AS2-L1-UIII: Procedures for Checking Automatic Transmission Fluid

        c. Job sheets

            JS1-L1-UIII: Road Testing an Automatic Transmission
            JS2-L1-UIII: Diagnosing Noise and Vibration Problems
            JS3-L1-UIII: Diagnosing Transmission Fluid Leakage and Poor Fluid Condition

    2. Lesson 2: SHOP TEST PROCEDURES FOR AUTOMATIC TRANSMISSIONS

        a. Information outline

        b. Assignment sheets

            AS1-L2-UIII: Procedures for Performing a Hydraulic Control Pressure Test
            AS2-L2-UIII: Procedures for Performing a Lockup Torque Converter Test

        c. Job sheets

            JS1-L2-UIII: Performing an Automatic Transmission Stall Test
            JS2-L2-UIII: Performing a Hydraulic Control Pressure Test
            JS3-L2-UIII: Performing a Lockup Torque Converter Test

E. Unit test

F. Answers to unit test

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NOTES TO THE INSTRUCTOR

A. Suggested approaches to teaching this unit

1. Students should do AS2-L1-UIII in conjunction with JS1-L1-UIII and JS3-L1-UIII; AS1-L2-UIII in conjunction with JS2-L2-UIII; and AS2-L2-UIII in conjunction with JS3-L2-UIII.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

UNIT III: TRANSMISSION/TRANSAXLE DIAGNOSIS

LESSON 1: EVALUATION AND DIAGNOSIS OF TRANSMISSION PROBLEMS

I. Terms and definitions

A. Engagement--The mechanical locking of gear sets. Engagement is achieved by hydraulic action.

B. Hydraulic pressure test--A test used to measure the hydraulic system's ability to meet transmission performance demands.

C. Runaway shift (overspeed)--A flaring of engine rpm upon gear change. Runaway shift occurs as a result of slippage of the gear set holding units.

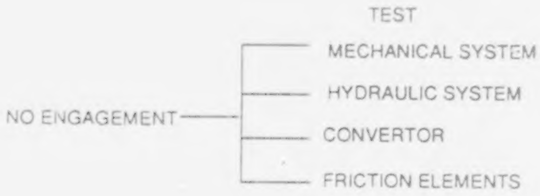
D. Stall test--A performance test of the torque converter and friction holding units in the transmission.

II. Analyzing driver complaints about the automatic transmission

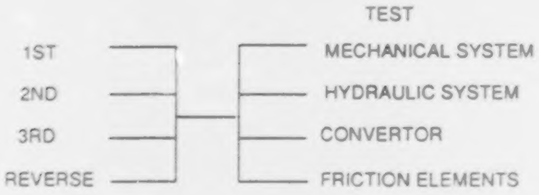
A. The driver's description of a transmission's performance can provide much helpful diagnostic information. Driver descriptions usually deal with four basic areas: engagement problems, shift quality problems, engine or transmission performance problems, and fluid problems. The specific problem described by the driver usually has one of six general causes: mechanical failure, hydraulic failure, friction element failure, converter failure, inadequate engine performance, or improper transmission adjustments. The technician must carefully consider the driver's description of the transmission problem, determine what types of system failure would cause such a problem, and choose a method for testing the suspected system.

1. Automatic transmission engagement problems

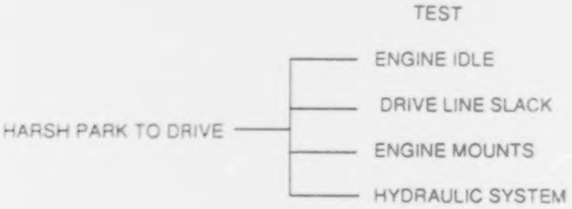
a. Failure of an automatic transmission to engage may involve several vehicle systems. The technician should always note if the transmission fails to engage in both forward and reverse or in one direction only.



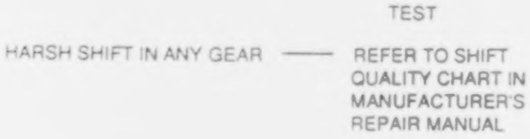
b. If the driver complains that the automatic transmission slips on engagement, the technician should determine whether the transmission is actually slipping or if the vehicle is merely accelerating too slowly. When verifying transmission slippage, the technician should also determine the gear range in which the slippage is taking place.


TEST
1ST
2ND
3RD
REVERSE
MECHANICAL SYSTEM
HYDRAULIC SYSTEM
CONVERTOR
FRICTION ELEMENTS

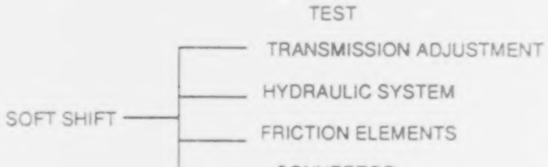
c. Rough engagement (abrupt or banging engagement) can occur in any gear range. The gear range in which the rough engagement occurs can indicate the source of the problem.


TEST
HARSH PARK TO DRIVE
ENGINE IDLE
DRIVE LINE SLACK
ENGINE MOUNTS
HYDRAULIC SYSTEM

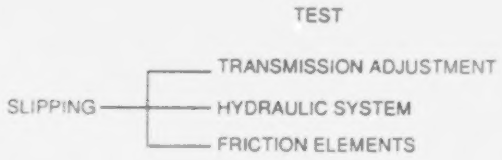
2. An automatic transmission with shift quality problems will engage in each gear range, but the shift will be noticeably soft or harsh, early or late, or exhibit other similar problems. Each shift quality problem may have a different set of causes, some of which are listed below.


TEST
HARSH SHIFT IN ANY GEAR
REFER TO SHIFT QUALITY CHART IN MANUFACTURER'S REPAIR MANUAL

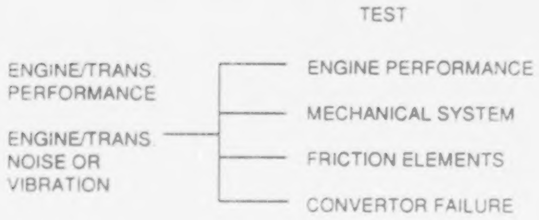
a. When a transmission soft shifts (sometimes called "mushy shift"), the gear engages indecisively or without a distinct shift feel.


TEST
SOFT SHIFT
TRANSMISSION ADJUSTMENT
HYDRAULIC SYSTEM
FRICTION ELEMENTS
CONVERTOR

b. It may be difficult to determine whether a transmission is soft shifting or slipping upon engagement. Both problems can have the same causes. However, the engine will usually flair when the transmission slips upon engagement. (Engine flair does not occur during soft shifting.) If engine flair is noted, the transmission is probably slipping rather than soft shifting.


TEST
SLIPPING
TRANSMISSION ADJUSTMENT
HYDRAULIC SYSTEM
FRICTION ELEMENTS

c. If the vehicle has engine/transmission performance problems, the driver will usually complain of poor acceleration, high engine rpm at cruising speeds, or lack of power (during hill climbing, for example). During the diagnosis of such problems, the technician will have to assess engine performance and compare it to transmission performance.


TEST
ENGINE/TRANS. PERFORMANCE
ENGINE/TRANS. NOISE OR VIBRATION
ENGINE PERFORMANCE
MECHANICAL SYSTEM
FRICTION ELEMENTS
CONVERTOR FAILURE

d. Transmission fluid problems, such as fluid leakage or excessive fluid usage, are the most common driver complaints. The driver may also be concerned about fluid condition. Like any working automotive fluid, transmission fluid requires service at scheduled intervals.

III. Road testing the automatic transmission

A. The road test is a very important step in diagnosing transmission problems. The road test allows the technician to experience the problem described by the driver. The road test also allows the technician to assess how the six general transmission systems perform both individually and as a unit. A clutch and band application chart is useful in diagnosing the failure of friction elements. An automatic shift speed chart is useful in indicating either failure of the hydraulic control system or poor engine performance. Refer to the appropriate service manual for these charts.

B. Procedure for performing a pre-road test on an automatic transmission

(NOTE: Perform the below test procedures before road testing the vehicle.)

1. Check the level and condition of the automatic transmission fluid.

(NOTE: The below procedure for checking transmission fluid covers a good many of today's vehicles. However, many new transmission designs have recently been put into production and the procedures for checking the fluid in these transmissions are often highly specialized and complex. Always consult the appropriate service manual for the specific vehicle to be serviced.)

(NOTE: A major cause of erratic transmission performance is low fluid level. Important diagnostic information can also be obtained by examining the fluid's condition.)

a. Make sure the transmission is at an operating temperature of at least 180°F. Some dipsticks have hot and cold indexes.

(NOTE: On most vehicles, running the engine at an idle will not bring the fluid up to 180°F. If the temperature of the fluid is not correct, the fluid level reading will be wrong. Usually about 10 to 20 minutes of driving time will bring the transmission fluid to the right temperature. The correct temperature may vary from vehicle to vehicle; always consult the proper service manual for the correct temperature for the vehicle to be serviced.)

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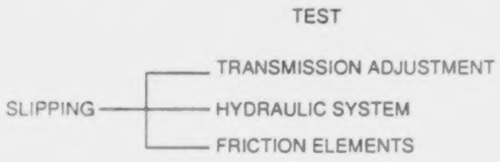
TEST
SLIPPING
TRANSMISSION ADJUSTMENT
HYDRAULIC SYSTEM
FRICTION ELEMENTS

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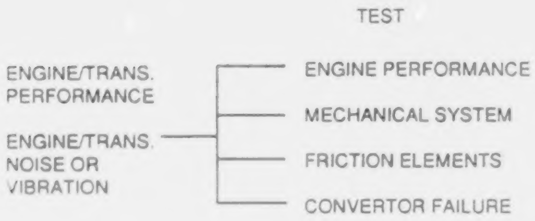
TEST
ENGINE/TRANS. PERFORMANCE
ENGINE/TRANS. NOISE OR VIBRATION
ENGINE PERFORMANCE
MECHANICAL SYSTEM
FRICTION ELEMENTS
CONVERTOR FAILURE

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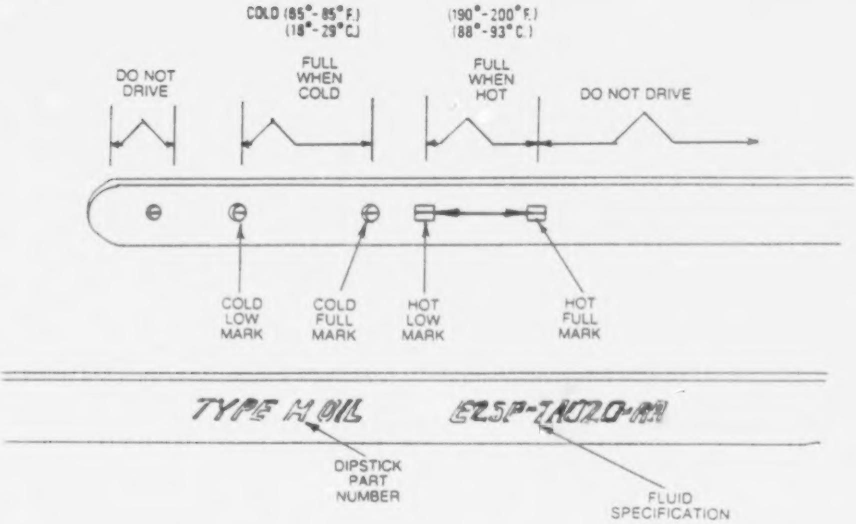
(NOTE: When checking the transmission on most vehicles, the engine should be running with the selector in park. The vehicle should also be on level ground. Procedures for checking fluid vary from vehicle to vehicle. Always consult the proper service information for the vehicle to be serviced.)


COLD (65°-85°F.)
(18°-29°C.)
(190°-200°F.)
(88°-93°C.)
DO NOT DRIVE
FULL WHEN COLD
FULL WHEN HOT
DO NOT DRIVE
COLD LOW MARK
COLD FULL MARK
HOT LOW MARK
HOT FULL MARK
TYPE H OIL
E25P-7A020-AA
DIPSTICK PART NUMBER
FLUID SPECIFICATION

b. Remove the automatic transmission fluid dipstick and wipe it off with a clean, soft rag.

c. Reinsert the dipstick until it bottoms and immediately remove it once again. Read the fluid level on the dipstick.

d. Let some of the fluid on the dipstick drip onto a piece of clean, white paper. This fluid will be analyzed in order to gain an indication of the condition of the rest of the fluid.

e. Once again wipe the dipstick clean and reinsert it.

f. Check the condition of the fluid on the white paper. The condition of the transmission fluid can indicate a number of transmission problems.

2. Check engine idle. Also inspect vacuum lines and transmission-related linkage.

(NOTE: Problems with engine idle, vacuum lines, and transmission-related linkage sometimes indicate external transmission problems that affect the internal operation of the transmission.)

a. Set engine fast and hot idle.

b. Check manual valve linkage by running the shift lever through the detent positions and feeling for the appropriate engagement of gears.

c. Check throttle valve linkage for proper connection and operation.

d. Make sure the vacuum modulator line is connected properly. Also check for other vacuum leaks associated with the intake vacuum.

e. Check for proper EGR valve activity.

f. Check forced downshift mechanism.

C. Procedure for road testing a vehicle

1. Check initial band and clutch engagement while the engine is idling. Note if engagement is harsh, normal, or delayed.

2. Following the manufacturer's procedure, record the speeds at which the minimum throttle upshifts occur. Note flaring of engine speed in each gear.

3. Record the speeds at which normal automatic upshifts occur. Also note the quality of the shifting.

4. Record the speeds at which wide open throttle upshifts from low speed occur. Note the quality of the shifting.

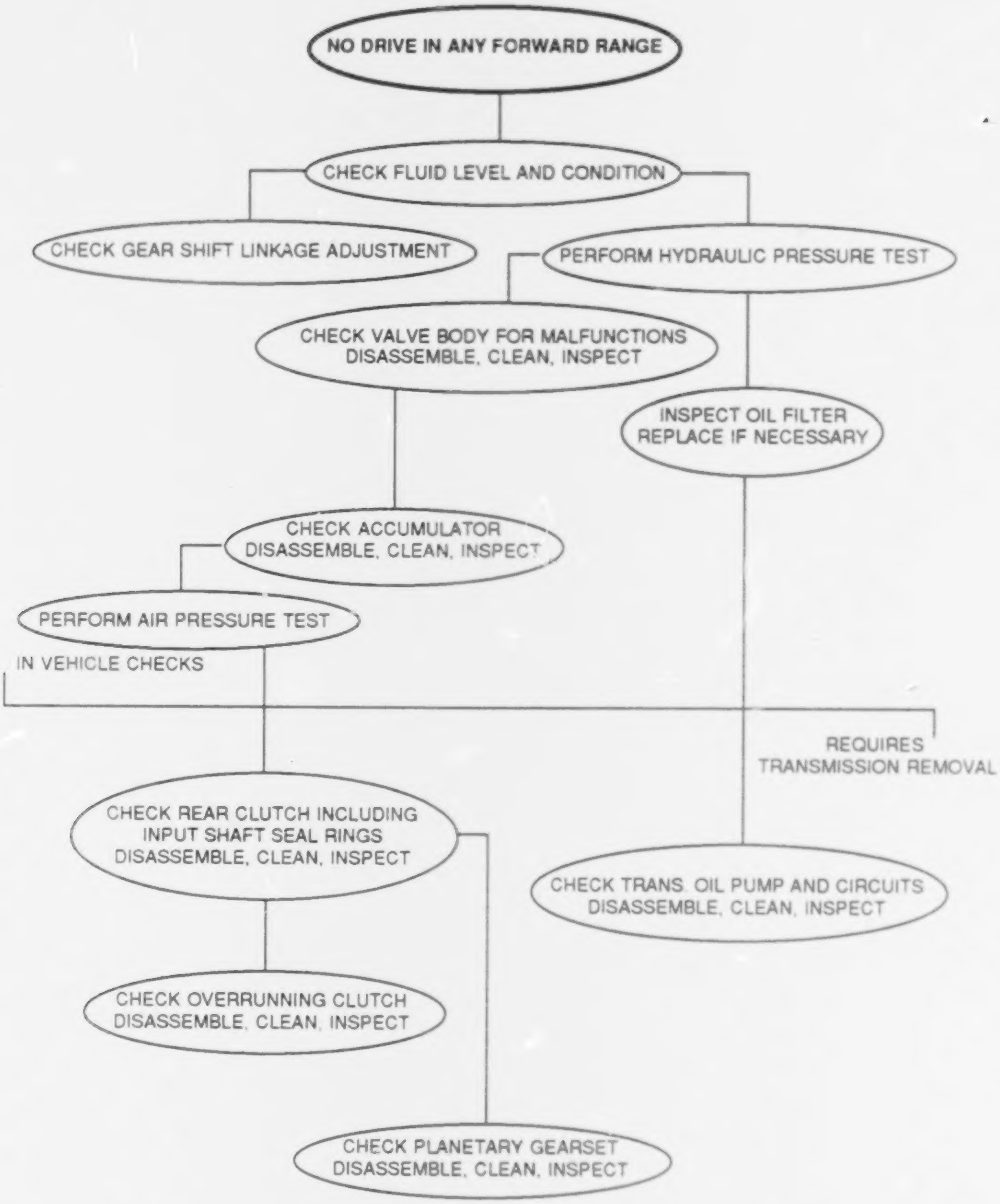
5. Record the speeds at which forced downshifts 3-2 and 2-1 occur.

6. Using the selector 3-1 (under 25 mph), 1-2, 2-3, and reverse, record the feel of the engagement.

7. Listen for gear or drive train noise as the vehicle is moving. Note the approximate location of the noise. Also note the speed at which the noise occurs.

D. Consider the results of the road test and recommend any needed repairs or additional testing.

(NOTE: Most manufacturers provide diagnostic flow charts or troubleshooting trees to assist in analyzing road test results. Usually additional shop tests are needed before final diagnosis can be made. A typical troubleshooting chart for testing an automatic transmission is provided on the next page.)


NO DRIVE IN ANY FORWARD RANGE
CHECK FLUID LEVEL AND CONDITION
CHECK GEAR SHIFT LINKAGE ADJUSTMENT
PERFORM HYDRAULIC PRESSURE TEST
CHECK VALVE BODY FOR MALFUNCTIONS DISASSEMBLE, CLEAN, INSPECT
INSPECT OIL FILTER REPLACE IF NECESSARY
CHECK ACCUMULATOR DISASSEMBLE, CLEAN, INSPECT
PERFORM AIR PRESSURE TEST
IN VEHICLE CHECKS
REQUIRES TRANSMISSION REMOVAL
CHECK REAR CLUTCH INCLUDING INPUT SHAFT SEAL RINGS DISASSEMBLE, CLEAN, INSPECT
CHECK TRANS. OIL PUMP AND CIRCUITS DISASSEMBLE, CLEAN, INSPECT
CHECK OVERRUNNING CLUTCH DISASSEMBLE, CLEAN, INSPECT
CHECK PLANETARY GEARSET DISASSEMBLE, CLEAN, INSPECT

IV. Diagnosing transmission/transaxle noise and vibration

A. The technician should always attempt to determine if noise and vibration in an automatic transmission has an internal or external source. Determining whether the source is internal or external is usually difficult because vibration and noise may seem to be coming several feet from its actual source. There are three basic categories of automatic transmission noises: (1) scrapes, grinds, and growls, (2) whines and squeals, and (3) bumps, rattles, and knocking. By paying attention to the type of the noise, the number of possible sources of the noise can usually be greatly reduced, thus saving repair time.

B. Types of noise and vibration

1. A defective transmission will sometimes make scraping, grinding, and growling noises. Though it is difficult to assign precise terms to the various noises caused by transmission problems, the listener will note an obvious difference between the "scraping" noise made by metal contacting metal and the "growling" noise of hydraulic activity. Problems deep within a transmission may sound like grinding noise. Some of the sources of scraping, grinding, and growling noises are listed below.

    a. Flywheel and torque converter contacting a stationary part

    b. Universal joints and drive line bearings

    c. Transmission pump clearance

    d. Drive shaft contacting the frame

    e. Drive axle shaft bearings

    f. Brake assemblies

2. High pitched noise sounding like whines and squeals usually comes from high-speed metal-to-metal contact. These kinds of noises can be very useful in locating transmission problems. If the noise can be heard only when the vehicle is in a particular gear, the problem is likely in that particular gear set. If whines and squeals are heard during torque converter stall tests, the problem is probably a defective one-way clutch. Components that may cause whines or squeals are listed below.

    a. Torque converter

    b. Gear sets

    c. Universal joints at low speed

    d. Wheel bearings at low speed

    e. Transmission bushings or thrust washers

3. Bumps, rattles, and knocking sounds can come from either loose parts or drive line units that are vibrating too rapidly. Determining when these noises occur and where they originate is an important step in diagnosing their causes. A broken flywheel, for example, may create a knocking sound when the transmission is in park and yet make no noise when the transmission is in drive. Some typical sources of bumps, rattles, and knocks are listed below.

   a. Broken flywheel (torque plate)

   b. Internal torque converter failure

   c. Loose torque converter

   d. Universal joints at high speed

   e. Out of balance drive line

   f. Worn CV joints

   g. Loose or broken transmission mounts

   h. Loose or out of round tires or wheels

C. In order to locate the source of transmission noise and vibration, the technician may road test the vehicle and/or listen to the transmission with a stethoscope.

1. In order to diagnose noise and vibration during a road test, the technician should note the following items.

   a. The approximate location from which the noise or vibration is coming

   b. The speed at which the vehicle is travelling when the noise occurs

   c. The rpm of the engine when the noise occurs

   d. Changes in noise or vibration due to changes in gear selection

   e. Changes in noise or vibration due to changes in the road condition

   f. Consistency of noise (in relation to vehicle operation)

   g. Changes in noise due to engine temperature

   h. Changes in noise during acceleration, coasting, or deceleration

   i. Changes in noise or vibration during cornering

2. Procedure for pinpointing noise and vibration with a stethoscope

   (**CAUTION:** Using a stethoscope to locate transmission noise can be a dangerous procedure. Great care should be exercised when performing this procedure. Perform this procedure only under the supervision of the instructor.)

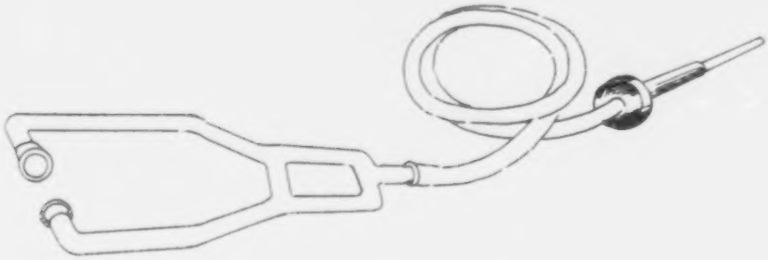
   a. Raise the vehicle on a hoist so that the drive wheels can turn.

(**CAUTION:** On front-wheel-drive vehicles, jack stands must be placed as far out on the A-frames as possible. Make sure the vehicle weight is on the stands. Doing so will prevent the CV joints from working at too great an angle.)

b. Start engine and operate the transmission in the drive range at which the noise or vibration occurred during the road test.

c. Observe the drive line for vibration or looseness.

d. Pinpoint the noise on nonrotating parts with the stethoscope.



3. Some typical problems that may be detected while the vehicle is being checked with the stethoscope are listed below.

a. Vibration at 1000-2000 rpm caused by torque converter imbalance or drive line vibration from loose parts or missing balance weights

(NOTE: Repair of torque converter imbalance is covered in Module VII, Manual Drive Train and Axles.)

b. High-pitched whine from the converter housing caused by low fluid level, clogged filter, defective pump, or defective one-way clutch

c. Grinding noise in neutral caused by gear train wear or disintegration

d. Knocking in the drive shaft(s) caused by worn universal or CV joints, worn support bearings, or bent drive line parts

V. Diagnosing and repairing fluid leakage and poor fluid condition

(NOTE: Diagnosing the cause of excessive fluid use and poor fluid condition can prevent transmission failure or assist in diagnosing the cause of the failure.)

A. Procedure for determining the cause of excessive fluid usage

1. Check transmission fluid level. Determine if fluid is low and if vehicle is using excessive amount of fluid. For this procedure, refer to item II-B-1 in this lesson. While checking fluid level, also check the condition of the fluid. This procedure can also be found in item II-B-1 in this lesson.

2. Determine if the fluid leak is external or internal. (Fluid that is leaking externally will seep out of the transmission and onto the ground or onto other vehicle components. Fluid that is leaking internally seeps through to the engine where it is burned.)

   a. External leaks can sometimes be located by a visual check. In most cases, however, visual checks can be difficult; for example, there may be more than one kind of fluid leaking out of the same general area. To assist in determining the source of the leak, use the following diagnostic chart.

DIAGNOSIS GUIDE-FLUID LEAKS

VISUALLY INSPECT FOR SOURCE OF LEAK. IF THE SOURCE OF LEAK CANNOT BE READILY DETERMINED, CLEAN THE EXTERIOR OF THE TRANSMISSION/TRANSAXLE. CHECK FLUID LEVEL. CORRECT IF NECESSARY.

THE FOLLOWING LEAKS MAY BE CORRECTED WITHOUT REMOVING THE TRANSMISSION/ TRANSAXLE:

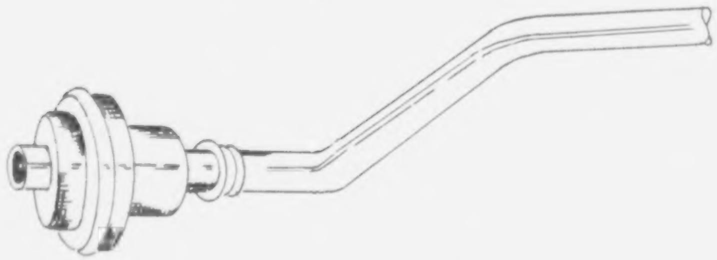
MANUAL LEVER SHAFT OIL SEA[illegible]
PRESSURE GAUGE PLUGS
NEUTRAL START SWITCH
OIL PAN RTV
OIL COOLER FITTINGS
EXTENSION HOUSING TO CASE BOLTS
SPEEDOMETER ADAPTER "O" RING
FRONT BAND ADJUSTING SCREW
EXTENSION HOUSING TO CASE BOLTS
SPEEDOMETER ADAPTER "O" RING
FRONT BAND ADJUSTING SCREW
DIFFERENTIAL BEARING RETAINER AXLE SEAL
REAR END COVER RTV
DIFFERENTIAL COVER RTV
EXTENSION HOUSING "O" RING
DIFFERENTIAL BEARING RETAINER RTV

THE FOLLOWING LEAKS REQUIRE REMOVAL OF THE TRANSMISSION/ TRANSAXLE AND TORQUE CONVERTOR FOR CORRECTION:

FLUID LEAKING FROM THE LOWER EDGE OF THE CONVERTOR HOUSING; CAUSED BY FRONT PUMP SEAL, PUMP TO CASE SEAL,OR TORQUE CONVERTOR WELD

CRACKED OR POROUS TRANSAXLE CASE

   b. Fluid that leaks internally seeps through the vacuum modulator diaphragm and on through the vacuum modulator. If the diaphragm is leaking, the fluid will be drawn up the hose and onto the intake manifold and burned in the engine. The amount of fluid burned will be small and, therefore, the vehicle will probably not smoke or give any other indication that it is burning fluid. To inspect for internal leaks, remove the hose at the modulator and look for fluid. The presence of fluid indicates that the modulator has ruptured and must be replaced.



MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

DIAGNOSING A TRANSMISSION/TRANSAXLE

Instructions: **Do the following tasks and answer the following questions. Write all responses on this sheet.**

1. Define soft shifting.

2. What are the typical symptoms of engine/transmission performance problems?

3. What items are checked during a pre-road test of a vehicle's transmission?

4. Name the three basic categories or types of noise and vibration usually made by a defective transmission and drive train.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

DIAGNOSING A TRANSMISSION/TRANSAXLE

(ANSWER SHEET)

1. When a transmission soft shifts (sometimes called "mushy shift"), the gear engages indecisively or without a distinct shift feel.
2. If the vehicle has engine/transmission performance problems, the driver will usually complain of poor acceleration, high engine rpm at cruising speeds, or lack of power (during hill climbing, for example).
3. Fluid level, engine idle, vacuum lines, and transmission related linkage
4. (a) scraping, grinding, and growling, (b) whining and squealing, and (c) bumping, rattling, and knocking

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

PROCEDURES FOR CHECKING AUTOMATIC TRANSMISSION FLUID

Instructions: **Do the following tasks on a separate sheet of paper.**

(HINT: Use an appropriate service manual.)

1. Record the make, model, and year of the vehicle to be serviced.
2. Develop a written procedure for checking the level of the vehicle's automatic transmission fluid. Make sure the procedure includes the temperature at which the fluid should be checked. Also include any other necessary specifications.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

ROAD TESTING AN AUTOMATIC TRANSMISSION

Equipment:

Transmission troubleshooting form (if available)
Safety glasses

(**CAUTION:** Never road test a vehicle without the permission of the instructor. Road test a vehicle only under the supervision of the instructor.)

Procedure: Evaluation 3 2 1 N

1. Wear safety glasses while doing all procedures on this job sheet. — — — —

   (NOTE: Most professional technicians use a troubleshooting chart when road testing an automatic transmission. If the proper chart is available, the instructor may prefer that it be used during the road test instead of the procedure outlined below. Ask the instructor if a chart should be used.)

2. Listen carefully to the driver's complaints. Record any relative information below. — — — —

3. Obtain the manufacturer's performance specifications from the service manual and record them below. — — — —

4. Following the procedure outlined below, perform a pre-road test on the vehicle. — — — —

   a. Complete AS2-L1-UIII. Following the procedure developed in item 2 of AS2-L1-UIII, check fluid level according to the manufacturer's procedure. Record the results below.

   b. Observe and record fluid condition.

c. Check and record engine idle rpm. Record and adjust rpm as needed.

d. Check throttle valve linkage and adjust as needed.

e. Check engine vacuum connections.

f. Check manual valve operation and adjust as needed.

g. Check for proper EGR valve operation.

h. Check forced downshift mechanism. Adjust as needed.

5. Following the procedure outlined below, road test the vehicle. ____

(**CAUTION:** Never road test a vehicle without the permission of the instructor. Road test a vehicle only under the supervision of the instructor.)

(NOTE: If possible, allow the vehicle's owner to drive. Doing so frees the technician to take notes.)

a. Record the speed at which initial band and clutch engagement occurs.

b. Record the speed at which the minimum throttle upshift occurs.

c. Record the speed at which automatic upshift occurs.

d. Record the speeds at which W.O.T. (wide open throttle) upshifts occur.

e. Record the speeds at which forced downshifts 3-2,2-1 occur.

f. Record the speed at which manual upshift occurs.

g. Listen for noise or vibration as the vehicle moves down the road.

6. Compare the results of the road test with the manufacturer's diagnostic chart. Record diagnosis and recommend repairs or additional tests below. ____

(NOTE: The service manual should contain a diagnostic chart.)

Average of above evaluations* ____

(*This average is a partial evaluation for Competency Ee1. Final evaluation for Ee1 will be made at the end of JS3-L2-UIII.)

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

DIAGNOSING NOISE AND VIBRATION PROBLEMS

Equipment:

Transmission troubleshooting form (if available)
Hoist
Stethoscope
Safety glasses

(**CAUTION:** The procedure outlined in this job sheet is very dangerous. Consult the instructor and the proper repair manual before performing this job sheet. Perform this job sheet only under the supervision of the instructor.)

Procedure:	Evaluation 3 2 1 N
1. Wear safety glasses while doing all procedures on this job sheet.	__ __ __ __
2. Question the driver about the noise or vibration.	__ __ __ __

(**NOTE:** Most professional technicians use a troubleshooting chart when road testing an automatic transmission. If the proper chart is available, the instructor may prefer that it be used during the road test instead of the procedure outlined below. Ask the instructor if a chart should be used.)

3. Following the procedure outlined below, road test the vehicle and record the appropriate information. ____

   a. At what speed does the vibration occur?

   b. At what engine rpm does the vibration occur?

   c. At what selector position does the vibration occur?

   d. Is the vehicle ride satisfactory?

   e. Does the noise occur during acceleration, deceleration, or coasting?

   f. What is the direction of the noise?

   g. Is the noise a scraping, a grinding, or a whining?

4. Raise the vehicle on a hoist so that the drive wheels do not touch the ground. ____

   (**CAUTION:** Follow all the appropriate safety procedures for lifting a vehicle.)

5. Using a stethoscope, isolate noise and vibration while someone runs the drive train at the speed that produces the noise. Record observations. — — — —

(**CAUTION:** The above procedure is very dangerous. Consult the instructor and the proper repair manual before performing this job sheet. Perform this job sheet only under the supervision of the instructor.)

6. Record the diagnosis and recommend repairs below. — — — —

a. Diagnosis

b. Recommended repairs.

Average of above evaluations* — — — —

(*This average is a partial evaluation for Competency Ee1. Final evaluation for Ee1 will be made at the end of JS3-L2-UIII.)

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

DIAGNOSING TRANSMISSION FLUID LEAKAGE AND POOR FLUID CONDITION

Equipment:

Hoist
Transmission troubleshooting form
Safety glasses

Procedure: Evaluation
3 2 1 N

1. Wear safety glasses while doing all procedures on this job sheet. __ __ __ __

2. Following the procedure outlined below, look for an external leak (a possible cause of excessive use of transmission fluid). __ __ __ __

   a. Complete AS2-L1-UIII. Following the procedure developed in item 2 of AS2-L1-UIII, check the level of the transmission fluid. Record observations.

   b. Raise the vehicle on a hoist.

      (**CAUTION:** Follow all the appropriate safety procedures for lifting a vehicle.)

   c. Clean the affected area if the leak is not apparent. Record observations.

   d. Start the vehicle.

   e. Look for a leak and make any necessary repairs. Record observations.

3. If no leak is found while performing item 2 above, test the vacuum modulator. Follow the procedure outlined below. __ __ __ __

   a. Remove the hose at the modulator.

   b. Look for automatic transmission fluid inside of the hose. If fluid is found, replace the modulator. Record observations.

4. Following the proceoure outlined below, diagnose poor fluid condition. __ __ __ __

   a. Start the vehicle.

   b. Withdraw the dipstick.

   c. Drip the fluid on white paper.

   d. Observe the color and odor of the fluid. Look for contamination. Record observations and recommend repairs.

Average of above evaluations* __ __ __ __

(*This average is a partial evaluation for Competency Ee1. Final evaluation for Ee1 will be made at the end of JS3-L2-UIII.)

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

UNIT III: TRANSMISSION/TRANSAXLE DIAGNOSIS

LESSON 2: SHOP TEST PROCEDURES FOR AUTOMATIC TRANSMISSIONS

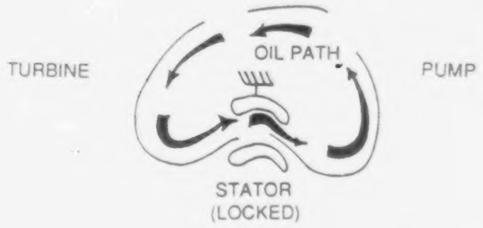
I. If the road test fails to identify the exact problem within the transmission, a shop test can provide the information needed to complete the diagnosis. Some basic shop procedures for diagnosing automatic transmissions are outlined below.

II. Torque converter stall test

A. As was discussed earlier in this module, the stator is locked during high torque converter pump speed and low turbine speed, thus allowing for the highest amount of fluid redirection through the stator. If, while the stator is locked, the pump is forcing the maximum amount of fluid against a stationary turbine but the engine speed cannot be increased, the torque converter is said to be stalled. There are three factors that can change the maximum stalled rpm: a failed one-way clutch in the stator; slipping clutches or bands; and an engine that lacks sufficient power to reach stall speed.

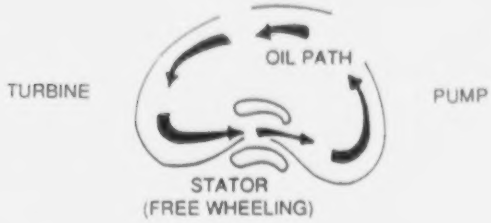
B. A one-way clutch usually fails for one of two reasons: the clutch is frozen or locked; the clutch is freewheeling in both directions.

1. If the stator locks as a result of a frozen one-way clutch, the fluid coupling of the pump and turbine will be blocked in the torque converter when the vehicle is at cruise speed. Because the coupling is blocked, the stator serves to slow the normal flow of fluid to the converter, thus reducing the vehicle's top speed by about 1/3 and limiting engine speeds to about 3000 rpm.



2. If the one-way stator clutch is slipping (or if the stator is allowed to slip backwards) while the fluid is leaving the turbine, then the fluid is not efficiently redirected into the pump, resulting in some loss of engine torque. As a result, the driver may notice poor, low-speed performance.

   (NOTE: A slipping one-way stator clutch will reduce stall speed by 30%.)



C. Slipping bands or clutches can be caused by either a loss of hydraulic control pressure or a failed band or clutch application system. If bands or clutches are slipping, the gear set holding system will fail to hold the turbine, causing the engine to overspeed. Listed below are specific problems that cause failed hydraulic control and failed band or clutch apply systems.

1. Problems causing hydraulic control failure
   a. A temporary loss of pump suction can create momentary aeration. Even momentary aeration can cause components to slip.
   b. A defective pump may not produce enough mainline pressure to maintain adequate holding force.
2. Problems causing the band or clutch apply system to fail
   a. If the servo has a ruptured seal or piston, the servo will lose holding power and allow the gear sets to slip.
   b. If the clutch band does not have an adequate friction surface, the transmission will slip.
   c. If the engine is underpowered, it may be unable to reach stall speed. An under-powered engine may produce many of the same results as a slipping one-way clutch.
3. Distinguishing between a slipping one-way clutch and an under-powered engine
   a. A failed one-way clutch will decrease rpm by 33%, while an under-powered engine will usually fall only from 200 to 300 rpm off stall rpm.
   b. An under-powered engine may misfire, causing the vehicle to jerk under a load.
   c. If the engine has a serious defect, blue or black smoke may come from the exhaust.

d. A persistent odor similar to rotten eggs indicates an overly rich fuel mixture in the catalytic converter. An overly rich fuel mixture can cause the engine to be underpowered.

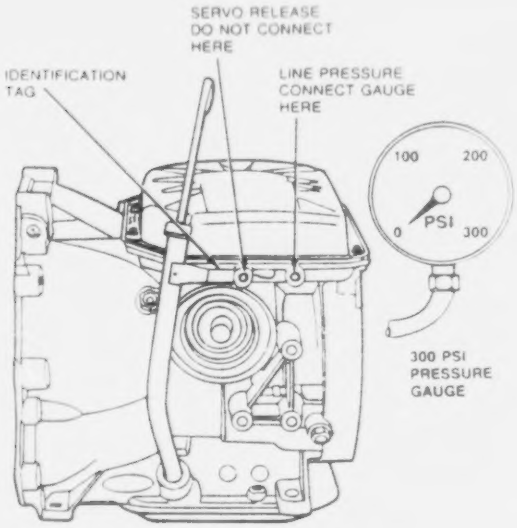
e. Backfiring during acceleration indicates engine problems.

III. When the transmission shifts poorly or slips, a test of the hydraulic control system pressure can pinpoint a failed hydraulic component. Depending upon the type of vehicle to be serviced, the technician should perform either a mainline control pressure test or an isolated component test.

A. On almost all vehicles, mainline automatic transmission pressure can be tested during a variety of operating conditions, allowing the technician to pinpoint which unit has failed and if control pressure is being regulated properly.

1. Although specific procedures for control pressure tests are similar, they may vary slightly from vehicle to vehicle. As was stated in the hydraulic control section, control pressure (mainline pressure) varies according to the gear range in which the transmission is operating. However, very low mainline pressure in a specific range points to a failed servo or piston seal--especially if slipping also occurs in that range and if pressure is normal in all the other non-associated gear ranges.

2. In an automatic transmission, mainline pressure varies according to the gear range selected, the governor pressure, the modulator pressure, and the throttle valve pressure. Testing the range of changes in control pressure based upon operating norms can help diagnose shift quality or engagement problems. The basic procedure involves installing the pressure gauges at the connecting points and measuring the control pressure while the governor, modulator, and throttle valve pressures are influencing the control pressure. The mainline pressure should respond in a predictable manner based on the manufacturer's specifications.



CONTROL PRESSURE CHECK (GAUGE INSTALLATION)

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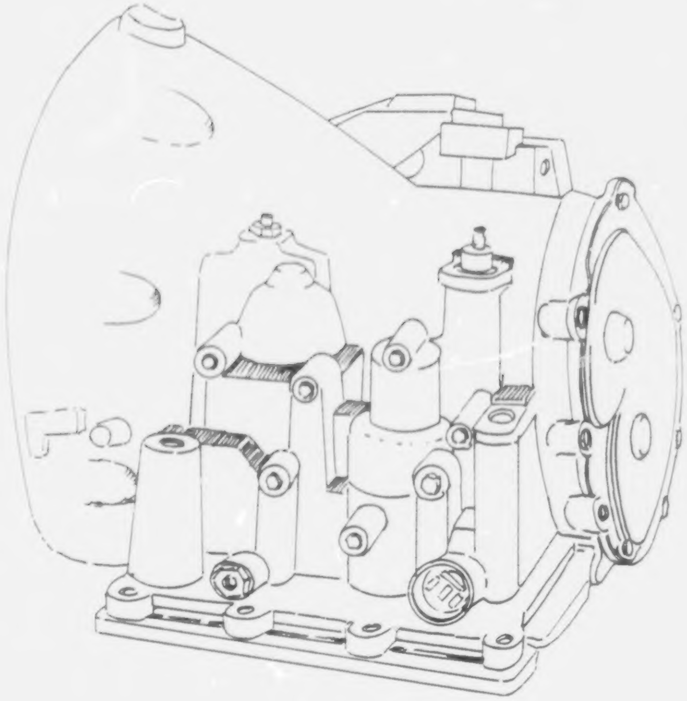
B. Some manufacturers provide pressure ports on the individual actuators so that these components can be tested individually (i.e. so an isolated individual component test can be performed). Because these components are located downstream of the valve body, an isolated component test can reveal whether the shift valve assemblies are functioning normally and whether the seals on the actuating apply units are holding. A mainline pressure (control pressure) test can indicate if the spool valves are moving, but generally it cannot directly measure band and clutch application.



IV. Performing a hydraulic control (mainline) pressure test

A. Obtain manufacturer's specifications. Specifications may vary greatly from vehicle to vehicle--even if the vehicles use the same transmission. Care must be taken to obtain the correct specifications and the proper procedures for the vehicle to be serviced.

B. Connect pressure gauge to the transmission pressure port.

(NOTE: Using the manufacturer's information, locate the control pressure tap, remove the plug, and install a gauge connection. Many gauge sets use quick disconnectors and a variety of adapters to assist in connecting the pressure gauge to the system.)

(NOTE: Make sure that the gauge has a range high enough to measure the system pressure as indicated by the manufacturer's specifications.)

C. Connect the tachometer. Engine rpm is an important part of determining how well the transmission pressure system is functioning.

D. Using a vacuum gauge, tee into the engine manifold vacuum. On vehicles equipped with vacuum modulators, the test procedure usually calls for matching control pressure to engine vacuum.

E. Test control pressure, using either the static or modulated method. The method to be used will depend upon the manufacturer of the vehicle.

1. The static test requires that control pressure be measured in each gear while the wheels are locked and the engine is at a specific rpm. (Each gear must be manually selected.) The static test measures the hydraulic integrity of the control circuit during initial engagement.

2. The modulated test measures not only the initial engagement pressure but also the changes in pressure that occur as a result of changes in engine vacuum, throttle position, or output rpm.

3. The procedure for testing the lockup torque converter is very complex and will vary from manufacturer to manufacturer. Usually the test will involve testing the following: clutch engagement unit; control valve position; and electrical control circuit.

V. Torque converter stall test

(NOTE: The torque converter stall test is not recommended by all manufacturers. Consult the appropriate service information before performing this test.)

A. Before performing the torque converter stall test, the technician should perform a pre-stall test that is similar to the pre-road test. The pre-stall test procedure is outlined below.

1. Check fluid level.
2. Observe fluid condition.
3. Check engine idle rpm.
4. Check throttle valve linkage.
5. Check engine vacuum.
6. Check EGR valve activity.
7. Check forced downshift linkage.

8. Check cooling system level and condition.

   (**CAUTION:** The torque converter test will overheat the automatic transmission fluid.)

9. Check emergency brake operation.

   (**CAUTION:** The torque converter test will put a great deal of stress on the brake system.)

10. Check the master fluid level.

11. Check the firmness of the brake.

12. Check W.O.T. travel with engine off.

B. Procedure for performing a torque converter stall test

(NOTE: When performing a torque converter stall test, make sure to use an accurate tachometer. The tachometer should be secured so that it will not fall off the vehicle or become entangled in the engine fan.)

1. Start engine.

2. Set the parking brake.

3. Firmly apply the brakes.

4. Make sure that no one is in front of the vehicle.

5. Place transmission in drive to allow time for positive engagement.

6. Accelerate engine to W.O.T. position.

   (**CAUTION:** If the engine exceeds 3000 rpm, immediately terminate the test. Avoid holding the throttle in the wide open position for more than 10 seconds.)

7. Observe and record tachometer reading.

8. Return the engine to idle.

9. Put the selector in park.

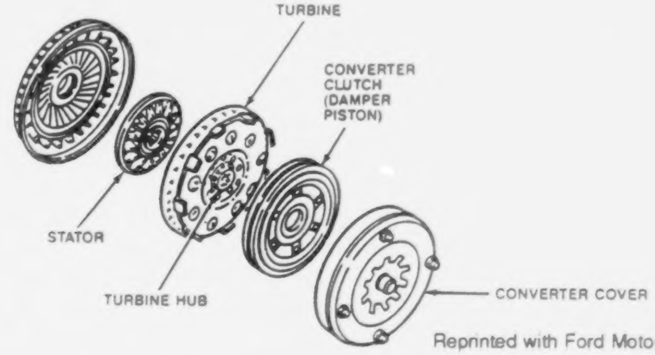
10. Run engine at 2000 rpm for one to two minutes.

11. Diagnose stall test results according to the chart found in the vehicle's repair manual.

VI. Testing lockup converters

A. A recent addition to automatic transmission is the lockup torque converter. The lockup torque converter reduces slipping between the pump and the turbine by locking the turbine to the converter housing at speeds above 30-45 mph. This prevents any power loss between the pump and turbine elements and thus increases gas mileage.

B. The lockup converter is a standard three-element torque converter with the addition of a hydraulic clutch. The clutch is applied by allowing mainline pressure to act upon a pressure plate assembly. The time of application is determined by a hydraulic control valve. The control valve is controlled by operating conditions such as engine rpm, input/output rpm, and engine temperature. The valve is also controlled by such devices as a brake switch, a vacuum relay switch, governor pressure, etc. The input received by the control valve is interrelated; therefore, a computer is used to process the input and to select the appropriate time for engagement and disengagement.



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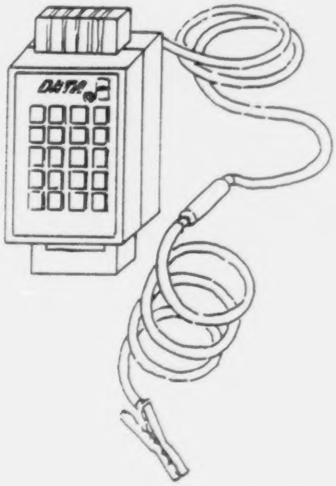
1. The typical procedure for determining hard clutch engagement (lockup) on lockup converter systems is to observe engine rpm when lockup occurs. Upon lockup, the technician should observe engine speed dropping to between 200 and 500 rpm. Such a drop indicates that the engine is not losing any torque to converter slippage.

2. To measure control valve activity, the technician must either create conditions to cause lockup on demand or monitor governor pressure to determine if lockup occurs at the right pressure. On electrically controlled valves, the circuit is simply energized to achieve lockup.

3. On computer-controlled lockup torque converters, proper sensor operation is critical to efficient lockup control. Sensors can be electrical, hydraulic, or mechanical. Specific procedures for testing sensor operation should be obtained from the manufacturer's service information.

4. Devices for monitoring streams of electrical data are used on some computer-controlled lockup torque converters. These devices interpret the data from the vehicle's computer and determine if the computer and electrical circuit are capable of causing the torque converter to lock up. Most monitors are hand-held and can be used while the vehicle is being test driven. The instrument reads the various sensor inputs and the computer engagement output signal to the control valve (solenoid).



(NOTE: Some transmissions use a planetary gear set located inside the torque converter. The gear set is connected to the transmission input shaft and is activated by a clutch pack. This produces a kind of mechanical lockup of the converter without the use of a torque converter clutch. This arrangement is tested like any clutch and planetary gear set. Test procedures vary depending on the vehicle model.)

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

PROCEDURES FOR PERFORMING A HYDRAULIC CONTROL PRESSURE TEST

Instructions: **Do the following tasks on a separate sheet of paper.**

(HINT: Use an appropriate service manual and the information provided in this unit.)

1. Record the make, model, and year of the vehicle to be serviced.
2. Develop a written procedure for performing a pressure test of the hydraulic control system. Procedures for this test vary greatly from vehicle to vehicle. Include all necessary specifications, all necessary equipment, and all necessary procedural steps for the vehicle to be serviced. Also include the location of all pressure ports and the circuits they are in.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

PROCEDURES FOR PERFORMING A LOCKUP TORQUE CONVERTER TEST

Instructions: **Do the following tasks on a separate sheet of paper.**

(HINT: Use an appropriate service manual and the information provided in this unit.)

1. Record the make, model, and year of the vehicle to be serviced.

2. Develop a written procedure for performing a lockup torque converter test. Procedures for this test vary greatly from vehicle to vehicle. Make sure to include procedures for the following: lockup engagement test; control valve operation test (electrical or mechanical); sensor input test; and computer test (using data stream). Include all necessary specifications, all necessary equipment, and all necessary procedural steps for the vehicle to be serviced.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

PERFORMING AN AUTOMATIC TRANSMISSION STALL TEST

Equipment:

Engine tachometer
Safety glasses

(**CAUTION:** The procedure outlined in this job sheet is very dangerous. Consult the instructor and the proper repair manual before performing this job sheet. Perform this job sheet only under the supervision of the instructor.)

(NOTE: The torque converter stall test is not recommended by all manufacturers. Consult the appropriate service information before performing this test.)

Procedure:

Evaluation
3 2 1 N

1. Wear safety glasses while doing all procedures on this job sheet. __ __ __ __

2. Following the procedure outlined below, perform a pre-stall test inspection. __ __ __ __

   a. Check the level of automatic transmission fluid.

   b. Observe the condition of automatic transmission fluid.

   c. Check engine idle rpm.

   d. Check throttle valve linkage.

   e. Check engine vacuum.

   f. Check EGR valve activity.

   g. Check forced downshift linkage.

   h. Check cooling system fluid level and condition.

      (**CAUTION:** The torque converter test will overheat the automatic transmission fluid.)

   i. Check emergency brake operation.

      (**CAUTION:** The torque converter test will put great stress on the brake system.)

   j. Check brake master cylinder fluid level.

   k. Check firmness of brake.

   l. Check W.O.T. travel with engine off.

3. Following the procedure outlined below, perform the torque converter stall test. ____

   a. Hook a tachometer to engine.

      (NOTE: When performing a torque converter stall test, make sure to use an accurate tachometer. The tachometer should be secured so that it will not fall off the vehicle or become entangled in the engine fan.)

   b. Start engine.

   c. Set the parking brake.

   d. Firmly apply the brakes.

   e. Make sure that no one is in front of the vehicle.

   f. Place transmission in drive to allow time for positive engagement.

   g. Accelerate engine to W.O.T. position or until the engine stalls.

      (**CAUTION:** If the engine exceeds 3000 rpm, immediately terminate the test. Avoid holding the throttle wide open for more than 10 seconds.)

   h. Observe and record tachometer reading.

   i. Return the engine to idle.

   j. Put the selector in park.

   k. Run the engine at 2000 rpm for 1 to 2 minutes.

   l. Diagnose stall test results according to the chart found in the vehicle's repair manual. The stall test chart applies to most vehicles.

4. Record stall test results. Compare the results with the chart found in the vehicle repair manual. Recommend repairs. ____

Average of above evaluations* ____

(*This average is a partial evaluation for Competency Ee1. Final evaluation for Ee1 will be made at the end of JS3-L2-UIII.)

JS2-L2-UIII

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

PERFORMING A HYDRAULIC CONTROL PRESSURE TEST

Equipment:

Pressure gauge and adapters
Transmission troubleshooting form
Vacuum gauge and fittings
Engine tachometer
Drain pan
Safety glasses

Procedure: Evaluation 3 2 1 N

1. Wear safety glasses while doing all procedures on this job sheet. ___ ___ ___ ___

2. Complete AS1-L2-UIII. Following the procedure developed in AS1-L2-UIII, perform a hydraulic control pressure test on the automatic transmission. ___ ___ ___ ___

   (NOTE: When connecting a pressure gauge to the automatic transmission ports, be prepared to capture any leaking fluid in the drain pan.)

3. Record results of the pressure test and recommend repairs below. ___ ___ ___ ___

Average of above evaluations* ___ ___ ___ ___

(*This average is a partial evaluation for Competency Ee1. Final evaluation for Ee1 will be made at the end of JS3-L2-UIII.)

JS3-L2-UIII

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

PERFORMING A LOCKUP TORQUE CONVERTER TEST

Equipment:

Engine tachometer
Hand-held data stream instrument (where applicable)
Pressure gauge and fittings (where applicable)
Safety glasses

Procedure:

		Evaluation 3 2 1 N
1.	Wear safety glasses while doing all procedures on this job sheet.	__ __ __ __
2.	Complete AS2-L2-UIII. Following the procedure developed in AS2-L2-UIII, perform a lockup torque converter test.	__ __ __ __
3.	Record findings of the test and recommend repairs below.	__ __ __ __

Average of above evaluations* __ __ __ __

(*This average is a partial evaluation for Competency Ee1. Final evaluation for Ee1 will be made at the end of this unit.)

FINAL EVALUATION INSTRUCTIONS

I. Determine the student's final evaluation for Competency Ee1 by averaging the evaluations of JS1-L1-UIII, JS2-L1-UIII, JS3-L1-UIII, JS1-L2-UIII, JS2-L2-UIII, and JS3-L2-UIII. Use the spaces provided below.

	Evaluation 3	 2	 1	 N
JS1-L1-UIII	__	__	__	__
JS2-L1-UIII	__	__	__	__
JS3-L1-UIII	__	__	__	__
JS1-L2-UIII	__	__	__	__
JS2-L2-UIII	__	__	__	__
JS3-L2-UIII	__	__	__	__
Final evaluation for Competency Ee1	__	__	__	__

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

UNIT III: TRANSMISSION/TRANSAXLE DIAGNOSIS

UNIT III TEST

SECTION A. **Read the statements below. Place a T or F in the blank each statement to indicate whether it is true or false.**

____ 1. Lockup torque converters have been standard equipment on most automatic transmissions for many years.

____ 2. A test of the hydraulic control system pressure can pinpoint failed hydraulic control systems.

____ 3. The condition of automatic transmission fluid can indicate automatic transmission problems.

____ 4. Excessive use of transmission fluid indicates transmission problems.

____ 5. Engagement is the mechanical locking of gear sets.

____ 6. Runaway shift is a flaring of engine rpm.

____ 7. A stall test is a performance test of the torque converter and friction holding units in the transmission.

____ 8. The driver's description of a transmission problem usually provides helpful diagnostic information.

____ 9. A defective torque converter can cause harsh engagement.

____ 10. The term "soft shift" refers to a transmission that slips upon engagement.

____ 11. If the vehicle has engine/transmission performance problems, the driver may complain of poor acceleration.

____ 12. Before road testing a vehicle, the technician should check the level and condition of the automatic transmission fluid.

____ 13. A defective vacuum modulator can cause the engine to burn transmission fluid.

____ 14. In most automatic transmissions, a one-way clutch allows the stator to freewheel in only one direction.

____ 15. Either hydraulic pressure problems or broken components can cause a transmission to slip.

____ 16. A hydraulic pressure test can be either a mainline test or an isolated component test.

____ 17. The stall test will generate much automatic transmission heat.

____ 18. Hydraulic pressure tests can be either the static or modulated type.

____ 19. Failure of a transmission to engage is usually caused by a faulty pressure relief system.

____ 20. Low fluid level will usually cause bands or clutches to slip.

____ 21. Slipping of an automatic transmission can be caused by problems in the hydraulic system.

____ 22. During a control pressure test, modulator vacuum should be checked.

____ 23. A problem in the automatic transmission's mechanical system can cause harsh engagement.

____ 24. Worn drive line parts can contribute to the slipping of an automatic transmission upon engagement.

____ 25. During the road test, the technician should measure and record initial band and clutch engagement.

____ 26. During a stall test, the engine should stall.

SECTION B. Select the best answer from the five choices listed.

____ 27. During the pre-road test inspection, the technician should not check the

a. level and condition of the transmission fluid.
b. throttle valve linkage.
c. operation of the EGR valve.
d. hydraulic pressures of components.
e. forced downshift mechanism.

____ 28. Scrapes, grinds, and growls within a transmission can be caused by

a. the clearance of the transmission pump.
b. the flywheel contacting a stationary surface.
c. the torque converter contacting a stationary surface.
d. the brake assemblies.
e. all of the above.

____ 29. Loose drive train parts can produce

a. bumps.
b. rattles.
c. knocking.
d. vibrating.
e. all of the above noises.

____ 30. If whines and squeals are heard during torque converter stall tests, the problem is probably a defective

a. one-way clutch.
b. brake shoe.
c. drive shaft.
d. hydraulic line.
e. microprocessor.

___ 31. If the stator becomes locked, the vehicle will perform poorly

a. at low speeds.
b. at high speeds.
c. in cold weather.
d. in hot weather.
e. at none of the above times.

___ 32. If the stator freewheels because of a slipping one-way clutch, the vehicle will perform poorly

a. at low speeds.
b. at high speeds.
c. in cold weather.
d. in hot weather.
e. at none of the above times.

___ 33. Mainline pressures are checked in order to determine if

a. a transmission problem occurs in a hydraulic or mechanical system.
b. a transmission problem occurs in one or more gears.
c. the transmission fluid is in good condition.
d. the torque converter is operating correctly.
e. drive line parts are worn.

___ 34. Before performing a stall test, the technician does not need to check the

a. engine cooling system.
b. firmness of the brakes.
c. engine vacuum.
d. valve activity.
e. conditions of motor mounts.

(NOTE: The student must obtain a minimum score of _____ on the Unit III Test in order to receive an evaluation for Competency Ee1.)

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

ANSWERS TO UNIT III TEST

1. f
2. t
3. t
4. t
5. t
6. t
7. t
8. t
9. f
10. f
11. t
12. t
13. t
14. t
15. t
16. t
17. t
18. t
19. f
20. t
21. t
22. t
23. t
24. f
25. t
26. f
27. d
28. e
29. e
30. a
31. b
32. a
33. a
34. d

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

UNIT IV: AUTOMATIC TRANSMISSION/TRANSAXLE MAINTENANCE AND ADJUSTMENT

UNIT OBJECTIVE

After completing this unit, the student should be able to service and make external adjustments on automatic transmissions/transaxles. The student will demonstrate mastery of the material by achieving a score of ____ on the unit test and successfully performing specific tasks.

SPECIFIC OBJECTIVES

After completing the lesson in this unit, the student should be able to:

Lesson 1. I. Identify terms and definitions associated with the maintenance and adjustment of automatic transmissions (Competency Ee2, Part I of the Unit IV Test).

II. Identify the procedures for changing fluid and filter in an automatic transmission (Competency Ee2, Part I of the Unit IV Test).

III. Identify the procedures for adjusting the manual and throttle valve linkage or the cable in an automatic transmission (Competency Ee2, Part I of the Unit IV Test).

IV. Identify the operating principles of and the maintenance procedures for bands within automatic transmissions (Competency Ee2, Part I of the Unit IV Test).

V. Identify the operating principles of and the maintenance procedures for automatic transmission sensors (Competency Ee3, Part II of the Unit IV Test).

VI. Demonstrate the ability to:

- a. Service fluid and filter in an automatic transmission (Competency Ee2, JS1-L1-UIV).
- b. Adjust the manual and throttle valve in an automatic transmission (Competency Ee2, JS2-L1-UIV).
- c. Adjust the bands in an automatic transmission (Competency Ee2, JS3-L1-UIV).
- d. Test and service ground switches, line switches, speed sensors, and hall effect switches in automatic transmissions or transaxles (Competency Ee3, JS4-L1-UIV).

ASE TASKS COVERED IN THIS UNIT

I. The job sheets in this unit cover ASE tasks B008-B011 and B021.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

UNIT IV: AUTOMATIC TRANSMISSION/TRANSAXLE MAINTENANCE AND ADJUSTMENT

CONTENTS OF THIS UNIT

A. Objective sheet

B. References

C. Notes to the instructor

D. Lesson plan

  1. Lesson 1: MAINTENANCE AND ADJUSTMENT OF THE AUTOMATIC TRANSMISSION/TRANSAXLE

    a. Information outline

    b. Assignment sheets

      AS1-L1-UIV: Maintaining and Adjusting a Transmission/Transaxle
      AS2-L1-UIV: Procedures for Servicing an Automatic Transmission Fluid and Filter
      AS3-L1-UIV: Procedures for Adjusting a Manual Valve and Throttle Valve
      AS4-L1-UIV: Procedures for Testing and Adjusting the Bands on an Automatic Transmission or Transaxle
      AS5-L1-UIV: Procedures for Testing and Servicing Grounding Switches, Line Switches, Speed Sensors, and Hall Effect Switches in Automatic Transmissions or Transaxles

    c. Job sheets

      JS1-L1-UIV: Servicing Fluid and Filter in an Automatic Transmission
      JS2-L1-UIV: Adjusting the Manual and Throttle Valve in an Automatic Transmission
      JS3-L1-UIV: Adjusting the Bands in an Automatic Transmission
      JS4-L1-UIV: Testing and Servicing Ground Switches, Line Switches, Speed Sensors, and Hall Effect Switches in Automatic Transmissions or Transaxles

E. Unit test

F. Answers to unit test

REFERENCES

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Ford Motor Company. 1990 Mustang Car Shop Manual. Ford Motor Company, 1990.

Ford Motor Company. 1990 Tempo/Topaz/Escort Car Shop Manual. Ford Motor Company, 1990.

Ford Parts and Service Division. 1980 Car Shop Manual. Ford Parts and Service Division, 1980.

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Webster, Jay. Principles of Automatic Transmission. Prakken Publications, 1974.

NOTES TO THE INSTRUCTOR

A. Suggested approaches to teaching this unit

   1. Students should do AS1-L1-UIV before taking the Unit IV Test. Students should do AS2-L1-UIV in conjunction with JS1-L1-UIV; AS3-L1-UIV in conjunction with JS2-L1-UIV; AS4-L1-UIV in conjunction with JS3-L1-UIV; and AS5-L1-UIV in conjunction with JS4-L1-UIV.

   2. To save time and materials, it may be desirable to have students perform two or more job sheets in this unit as one operation.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

UNIT IV: AUTOMATIC TRANSMISSION/TRANSAXLE MAINTENANCE AND ADJUSTMENT

LESSON 1: MAINTENANCE AND ADJUSTMENT OF THE AUTOMATIC TRANSMISSION/TRANSAXLE

I. Terms and definitions

A. Apply pin gauge--A special gauge used to measure band wear before band adjustment.

B. Band adjustment screw--A screw used to pretension a band. The band adjustment screw controls the length of band application.

C. Cable snaplock--A device used to secure the position of the cable housing in relation to the cable. The cable snaplock controls cable length.

D. Converter drain--A plug used to drain the automatic transmission fluid that is trapped in the converter. Converter drains are not used in all automatic transmissions.

E. Dimpled flange--A raised area on the transmission sealing flange caused by overtightening of the pan bolts. A dimpled flange can cause fluid to leak and must be straightened.

F. Grounding switch--A type of switch that completes the circuit by providing a current path to ground.

G. Kickdown adjustment--The adjustment of the point at which kickdown is initiated. Kickdown adjustment is achieved by adjusting the length or contact point of a cable or linkage.

H. Line contact switch--A switch that closes a circuit in order to provide a current path through the line.

I. Multiple contact switch--A switch that has more than one contact switch. A multiple contact switch may have line or grounding switches with multiple positions.

J. Pawl--A metal detent used to locate and position the manual valve for each selected gear range.

K. Petroleum jelly--A petroleum product that is mixed with automatic transmission fluid and used for assembly adhesive. Petroleum jelly is an appropriate substitute for gasket sealers for holding components in place during assembly.

L. Shift gate--A detent area that allows the pawl to locate and position the manual valve.

II. Changing fluid and filter in an automatic transmission

A. The service interval for a transmission depends upon three factors: the manufacturer's recommendation; severity of use; and internal transmission wear and failure.

1. Manufacturers usually recommend fluid and filter service every 50,000 miles. Some manufacturers stipulate a more frequent interval due to unique design features of their transmissions. The proper service manual should be consulted for specific service intervals.

2. Vehicles that undergo heavy or severe use (pulling a trailer or travelling through mountainous regions, for example) should adjust service intervals accordingly. The service manual will provide specific recommendations for vehicles undergoing heavy service.

   (NOTE: A good way to determine that the fluid needs service is by examining its color and odor; also check for contaminants in the fluid.)

3. When internal transmission components, such as clutches and bands, engage and disengage, a small amount of friction material is worn away. After a long period of transmission operation, residue of the worn friction material may collect in the fluid, causing it to darken. If, however, flakes as large as a grain of sand are found in the fluid, the transmission may be suffering an excessive loss of friction material. The cause of the loss must be determined before the fluid and filter are changed.

B. Depending on the transmission design, fluid can be drained from an automatic transmission either through a drain plug or a detachable filter pipe. The transmission design may also allow fluid to be drained by tilting the pan.

1. Some transmission pans have a threaded plug that can be removed to allow fluid to drain out. The drain plug usually has straight threads and is sealed by a metal or fibrous ring seal around the plug. The plug's ring seal must be replaced when the fluid is charged.

2. Some older transmission designs use a detachable filter pipe screw (essentially a screw-in filter tube) that can be removed to allow the fluid to drain. This system often uses a flared tube seal, which should not require replacement.

3. Most of today's vehicles have no specific device for draining transmission fluid; instead, the technician must remove enough bolts so the pan can be popped open on one side, allowing about half the fluid to leak down to the flange of the pan. Once the fluid stops leaking out, the technician removes the remaining bolts and gently drops the pan down and dumps the remaining fluid.

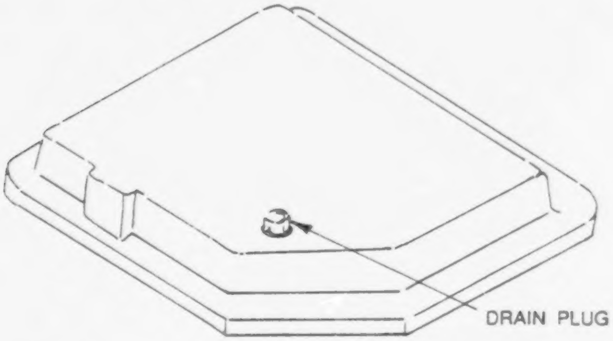
C. By examining the material deposited on the bottom of the pan, the technician can diagnose internal transmission troubles more efficiently. The below chart serves as a guide to examining pan deposits.

Deposit Condition	Cause	Repair
Small black deposit.	Normal wear.	Fluid and filter change, band adjustment if applicable.
Large black deposit with flakes evident.	Clutch/band failure eminent.	Rebuild ASAP.
Silver flakes or brown chunks.	Thrust washer failure.	Rebuild.
Silver color to fluid when swirled by finger. Looks like aluminum paint.	Torque convertor.	Rebuild, flush all systems.
Brown residue inside transmission (varnish appearance).	Severe overheating (find source of overheat).	Fluid and filter or rebuild depending severity.

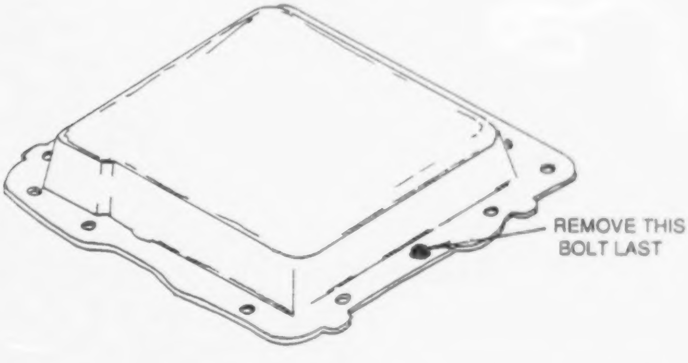
D. When changing the automatic transmission fluid filter, observe the cautions outlined below.

1. When removing the filter, watch for any springs or valves that are held in by the filter flange.
2. Never use a shop towel to clean in or around the filter flange. A piece of lint could be left in the opening, eventually reaching the valve body and jamming the spool valves.
3. Align gasket properly when installing the filter.
4. Torque the screws or bolts if stipulated by the manufacturer.

E. The overtightening of pan bolts causes dimples to form on the pan sealing flange. To rid the surface of dimples, use a flat metal backing and a ball-peen hammer to reverse and flatten the dimples. Do not hammer the flange excessively ; doing so may distort its basic shape. When installing the pan gasket, use only petroleum jelly to hold the gasket in place. Do not use gasket sealers. Gasket sealers can be dissolved by the automatic transmission fluid and relocated throughout the transmission.



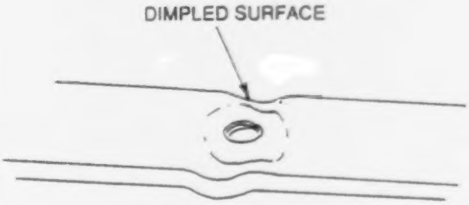
F. When installing the automatic transmission fluid pan, start all the bolts before fully tightening any single bolt. Make sure that the gasket is straight. Use a torque wrench to tighten bolts. The most frequent cause of pan leaks is pan bolts that have been overtightened.



(NOTE: Some vehicles have a torque converter drain that can be used to service the converter. If this is the case, follow the manufacturer's instructions for draining the torque converter.)

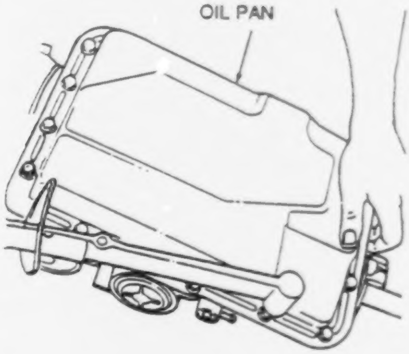
III. Adjusting manual and throttle valve linkage or cable

A. Adjusting a manual linkage or cable involves indexing the gear shift lever position to that of the manual valve. Inside the transmission there is a detent pawl device that positions the manual valve according to a set of shift gates. The shift gates are slotted positions that coincide with the required manual valve position. The shift lever usually has some kind of position indicator; the shift lever may also have its own detent in park. An adjustment device is provided somewhere between the two systems. The adjustment device may be either a slip joint or snaplock cable or some other kind of adjustable link. Because the manual valve and shift gate position is not adjustable, all other linkage adjustments are referenced to the manual valve position. Sometimes a separate neutral safety switch is also needed. The service manual outlines the procedure required for each specific model.



B. The transmission may use either a downshift throttle valve or a shift modifying and downshift throttle valve.

1. A shift modifying and downshift throttle valve has a continuous effect upon the shift signal generated by the governor. By monitoring the throttle opening, the throttle valve can tailor the shift sequence according to the driver's desires while allowing the governor to shape the time of shifts according to engine load. If the throttle valve travels its maximum distance, it will force a downshift to the next lower gear (passing gear). The valve opening is adjusted according to throttle opening like the manual valve. A variety of adjustment devices (ranging from sliding joints to cable snaplocks) are used. Consult the service manual for the specific adjustment procedure.

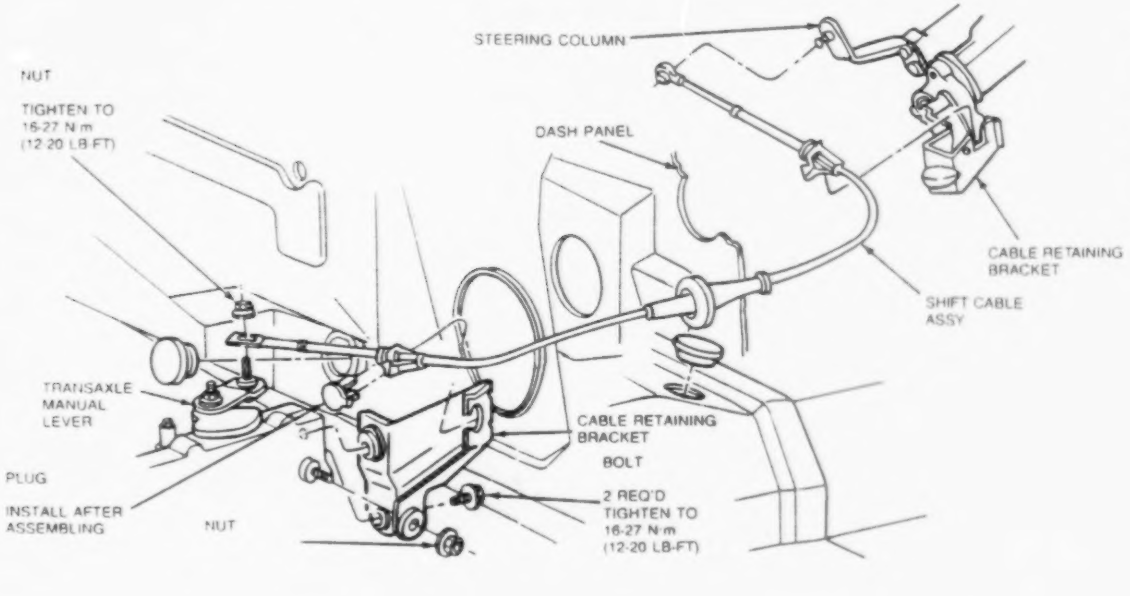


2. On a transmission with a vacuum modulator, the throttle valve linkage is sometimes not a throttle valve at all but is used only to force downshift. The relationship of forced downshift to wide open throttle position can be adjusted. Adjustment is about the same as in the shift modifying type. Sometimes an electrical detent (forced downshift) solenoid is used. An electrical detent switch is contacted by the wide open throttle, energizing a detent solenoid valve and forcing a downshift.

IV. On some transmissions, bands are used to hold planetary ring gears to achieve the desired gear ratio. Bands are subject to wear and, as a result, require occasional adjustment. The frequency depends on the design of the transmission and the severity of use. Bands may be adjusted externally or internally. Some transmissions use nonadjustable bands along with a special apply pin gauge to determine the serviceability of the band.

A. Band adjustment should always include pretightening the band and setting band to drum clearance.

1. A threaded anchor screw is used to adjust the tightness of the band around the drum. The initial band adjustment procedure is to tighten the band to a predetermined torque specification. This procedure requires an inch pounds torque wrench with a special adapter that fits the head of the screw. Sometimes during the adjustment pretightening, a gauge is placed between the screw end and the band apply pin.


STEERING COLUMN
NUT
TIGHTEN TO
16-27 N m
(12-20 LB-FT)
DASH PANEL
CABLE RETAINING
BRACKET
SHIFT CABLE
ASSY
TRANSAXLE
MANUAL
LEVER
CABLE RETAINING
BRACKET
BOLT
PLUG
INSTALL AFTER
ASSEMBLING
NUT
2 REQ'D
TIGHTEN TO
16-27 N m
(12-20 LB-FT)

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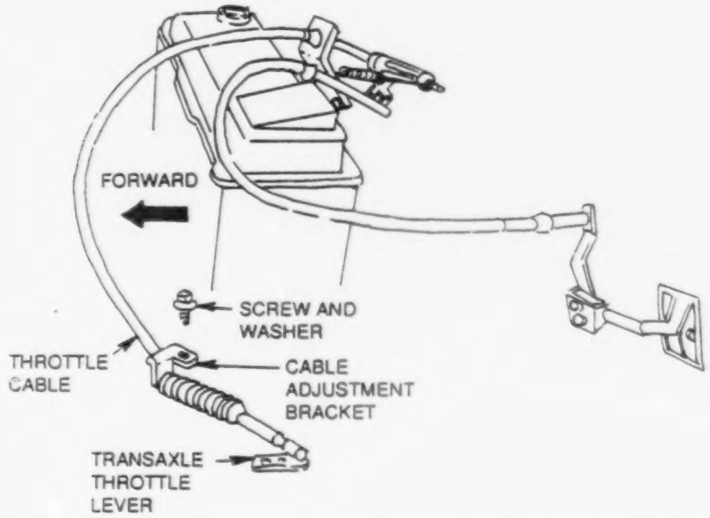
2. The second part of the band adjustment procedure requires the technician to establish a specific clearance between the drum and the band. The clearance is established by backing off the pretightened band screw a specified number of turns and then locking the screw in position with a jam nut. Some jam nuts are self-locking and must be replaced after each adjustment.



V. Some automatic transmissions may contain electrical sensors. These sensors are used to control components and functions external to the transmission. These components and functions include the starter circuit, the backup lights, the control of output shaft speed, and the overdrive engagement. The sensors fall into two basic categories: switches and speed sensors.

A. There are three types of switches used in transmissions: grounding switches; line switches, and multiple contact switches.

1. Grounding switches, when activated, complete the circuit by providing a current path to ground. Grounding switches establish ground through a single wire. Some grounding switches are adjustable and must be positioned in relation to the device that activates them.

2. A line switch (sometimes called a single-throw-single-pole switch) opens and closes a circuit. A line switch has two wires, one coming from the source and the other going to the load. Line switches also require adjustment in some vehicles.

3. A multiple contact switch may have multiple in-and-out contacts and a variety of off-and-on positions. The multiple contact switch may incorporate several different control possibilities.

B. Speed sensors are used to monitor the rotational speed of internal transmission components, such as the output shaft rpm. There are two basic types of speed sensors: magnetic pickup and hall effect.

1. In a magnetic pickup speed sensor, a magnet is rotated past a fixed coil. As the magnet comes near the coil, a magnetic field is broken across the coil, thus inducing a current in the coil. The number of weak currents induced in the coil is counted by computerized circuitry, which then produces a signal indicating the speed of rotation (rpm).

2. The hall effect sensor uses a special type of stationary hall effect switch and a rotating component which is slotted or grooved. As the slots pass by the hall effect switch, a signal is generated in relation to the passing of the slots or grooves. Computer circuitry counts the signals and produces another signal indicating output rpm.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

MAINTAINING AND ADJUSTING A TRANSMISSION/TRANSAXLE

Instructions: **Do the following tasks and answer the following questions. Write all responses on this sheet.**

1. Define the terms listed below.

Apply pin gauge

Band adjustment screw

Cable snaplock

Converter drain

Dimpled flange

Grounding switch

Kickdown (forced downshift) adjustment

Line contact switch

Multiple contact switch

Pawl

Petroleum jelly

Shift gate

2. Name three factors affecting automatic transmission fluid service intervals.

3. Name three methods for draining automatic transmission fluid from the transmission pan.

4. Why should a shop towel not be used to clean transmission parts?

5. Describe pan flange dimpling and the procedure for correcting it.

6. Describe the procedure for pretightening the band.

7. Describe the procedure for adjusting the drum to band clearance.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

MAINTAINING AND ADJUSTING A TRANSMISSION/TRANSAXLE

(ANSWER SHEET)

1. An apply pin gauge is a special gauge used to measure band wear before band adjustment.

   A band adjustment screw is a screw used to pretension a band.

   A cable snaplock is a device used to secure the position of the cable housing in relationship to the cable. The cable snaplock controls cable length.

   A converter drain is a drain plug used to service the automatic transmission fluid that is trapped in the converter. Converter drains are not used in all automatic transmissions.

   A dimpled flange refers to a raised area on a flange. This raised area is caused by overtightening of the pan bolts.

   A grounding switch completes an electrical circuit by providing a current path to ground.

   A pawl is a metal detent used to locate and position the manual valve for each selected gear range.

   A shift gate is a detent area that allows the pawl to locate and position the manual valve position.

2. The manufacturer's recommendation, severity of use, and internal transmission wear and failure

3. Depending on the transmission design, fluid can be drained from an automatic transmission through a drain plug, a detachable filter pipe, or by tilting the pan.

4. A shop towel should never be used to clean transmission parts because a piece of lint could be left in an opening, eventually reaching the valve body and jamming the spool valves.

5. The overtightening of pan bolts causes dimples to form on the pan sealing flange. To straighten a dimpled surface, use a flat metal backing and a ball-peen hammer to reverse and flatten the dimples.

6. The initial band adjustment procedure is to tighten the band to a predetermined torque specification. This procedure requires an inch pounds torque wrench with a special adapter that fits the head of the screw. Sometimes during the adjustment pretightening, a gauge is placed between the screw end and the band apply pin.

7. The second part of the band adjustment procedure requires the technician to establish a specific clearance between the drum and the band. The clearance is established by backing off the pretightened band screw a specified number of turns and then locking the screw in position with a jam nut. Some jam nuts are self-locking and must be replaced after each adjustment.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

PROCEDURES FOR SERVICING AN AUTOMATIC TRANSMISSION FLUID AND FILTER

Instructions: **Do the following tasks on a separate sheet of paper.**

(HINT: Use an appropriate service manual.)

1. Record the make, model, and year of the vehicle to be serviced.
2. Identify the appropriate method for draining the vehicle's automatic transmission fluid and develop a written procedure for servicing the fluid and the filter. Make sure the procedure includes instruction for straightening the pan flange and draining the torque converter, if necessary.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

PROCEDURES FOR ADJUSTING A MANUAL VALVE AND THROTTLE VALVE

Instructions: **Do the following tasks on a separate sheet of paper.**

(HINT: Use an appropriate service manual.)

1. Record the make, model, and year of the vehicle to be serviced.
2. Develop a written procedure for adjusting the vehicle's manual valve and throttle valve.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

PROCEDURES FOR TESTING AND ADJUSTING THE BANDS ON AN AUTOMATIC TRANSMISSION OR TRANSAXLE

Instructions: **Do the following tasks on a separate sheet of paper.**

(HINT: Use an appropriate service manual.)

1. Record the make, model, and year of the vehicle to be serviced.
2. Develop a written procedure for adjusting the bands on the vehicle's automatic transmission or transaxle.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

PROCEDURES FOR TESTING AND SERVICING GROUNDING SWITCHES, LINE SWITCHES, SPEED SENSORS, AND HALL EFFECT SWITCHES IN AUTOMATIC TRANSMISSIONS OR TRANSAXLES

Instructions: **Do the following tasks on a separate sheet of paper.**

(HINT: Use an appropriate service manual.)

(NOTE: Development of these procedures requires a basic understanding of VOM operation and testing. For information on VOM use and testing, refer to the Electrical Systems module.)

1. Record the make, model, and year of the vehicle to be serviced.
2. Develop a written procedure for testing and servicing all switches and sensors in the vehicle's automatic transmission or transaxle.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

SERVICING FLUID AND FILTER IN AN AUTOMATIC TRANSMISSION

Equipment:

Hoist or jacks and jack stands
Drain pan
Safety glasses

Procedure:	Evaluation 3 2 1 N
1. Wear safety glasses while doing all procedures on this job sheet.	__ __ __ __
2. Complete AS2-L1-UIV. Following the procedure developed in item 2 of AS2-L1-UIV, service the vehicle's automatic transmission fluid and filter. Also inspect the condition of the fluid and the fluid deposits in the pan. Record observations.	__ __ __ __

(**CAUTION:** Do not clean the internal portion of the transmission or internal transmission components with a cloth rag. Lint may enter the hydraulic circuit.)

Average of above evaluations* __ __ __ __

(*This average is a partial evaluation for Competency Ee2. Final evaluation for Ee2 will be made at the end of JS2-L2-UV.)

JS2-L1-UIV

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

ADJUSTING THE MANUAL AND THROTTLE VALVE IN AN AUTOMATIC TRANSMISSION

Equipment:

Hoist or jack and jack stands
Safety glasses

Procedure:		Evaluation 3	 2	 1	 N
1.	Wear safety glasses while doing all procedures on this job sheet.	___	___	___	___
2.	Complete AS3-L1-UIV. Using the procedure developed in item 2 of AS3-L1-UIV, adjust the automatic transmission's manual valve and throttle valve.	___	___	___	___
	Average of above evaluations*	___	___	___	___

(*This average is a partial evaluation for Competency Ee2. Final evaluation for Ee2 will be made at the end of JS2-L2-UV.)

JS3-L1-UIV

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

ADJUSTING THE BANDS IN AN AUTOMATIC TRANSMISSION

Equipment:

Hoist or jack and jack stands
Inch pound torque wrench
Safety glasses

Procedure:

Evaluation
3 2 1 N

1. Wear safety glasses while doing all procedures on this job sheet. ___ ___ ___ ___

2. Complete AS4-L1-UIV. Following the procedure developed in item 2 of AS4-L1-UIV, adjust the automatic transmission bands. ___ ___ ___ ___

   (NOTE: Some lock nuts must be replaced each time they are loosened.)

   Average of above evaluations* ___ ___ ___ ___

   (*This average is a partial evaluation for Competency Ee2. Final evaluation for Ee2 will be made at the end of JS2-L2-UV.)

JS4-L1-UIV

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

TESTING AND SERVICING GROUND SWITCHES, LINE SWITCHES, SPEED SENSORS, AND HALL EFFECT SWITCHES IN AUTOMATIC TRANSMISSIONS OR TRANSAXLES

Equipment:

DVOM
Hoist, or jack and jack stand
Safety glasses

(NOTE: Performance of the tasks on this job sheet requires a basic understanding of VOM operation and testing. For information on VOM use and testing, refer to the Electrical Systems module.)

(NOTE: Not all transmissions have all of the sensors listed below.)

Procedure: Evaluation 3 2 1 N

1. Wear safety glasses while doing all procedures on this job sheet. ___ ___ ___ ___

2. Complete AS5-L1-UIV. Following the procedure developed in item 2 of AS5-L1-UIV, inspect, test, and adjust the grounding switch in the automatic transmission. Record observations. ___ ___ ___ ___

3. Following the procedure developed in item 2 of AS5-L1-UIV, inspect, test, and adjust the line switch in the automatic transmission. Record observations. ___ ___ ___ ___

4. Following the procedure developed in item 2 of AS5-L1-UIV, inspect, test, and adjust the speed sensor in the automatic transmission. ___ ___ ___ ___

5. Following the procedure developed in item 2 of AS5-L1-UIV, inspect, test, and adjust the hall effect switch in the automatic transmission. ___ ___ ___ ___

Average of above evaluations* ___ ___ ___ ___

(*This average is a partial evaluation for Competency Ee3. Final evaluation for Ee3 will be made at the end of JS3-L2-UV.)

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

UNIT IV: AUTOMATIC TRANSMISSION/TRANSAXLE MAINTENANCE AND ADJUSTMENT

UNIT IV TEST

PART I. SERVICING THE TRANSMISSION

SECTION A. Match the following terms with their appropriate definitions.

____ 1. A detent area that allows the pawl to locate and position the manual valve.

____ 2. A product which mixes with automatic transmission fluid and is used as assembly adhesive.

____ 3. A metal device used to locate and position the manual valve for each selected gear.

____ 4. A raised area on the transmission sealing flange which is caused by overtightening.

____ 5. A device used to measure band wear.

a. apply pin gauge

b. band gauge

c. dimple flange

d. pawl

e. petroleum jelly

f. shift gate

g. shifter linkage

SECTION B. **Read the statements below. Place a T or F in the blank each statement to indicate whether it is true or false.**

____ 6. The band adjustment screw has to be replaced after each adjustment.

____ 7. A grounding switch provides a current path through an electrical wire by closing the circuit.

____ 8. Some torque converters can be drained.

____ 9. Service intervals for most automatic transmissions are about 25,000 miles.

____ 10. Most transmission pans will have a drain plug.

____ 11. When removing a transmission filter, watch for any springs or valves that are held by the filter flange.

____ 12. Gasket sealers should be used to prevent leaks at the transmission pan.

____ 13. Throttle valves are used only to force downshifts.

____ 14. All procedures for adjusting automatic transmission bands include a common set of procedures.

____ 15. A jam nut is used to hold the band adjustment screw in place.

____ 16. Speed sensors monitor the rotational speed of the input shaft.

____ 17. A magnetic pickup uses a special switch with slots or grooves.

____ 18. When installing the transmission pan, the technician should install all the bolts before tightening any one of the bolts.

____ 19. The material deposited in the bottom of the automatic transmission pan can be used for diagnosing transmission problems.

____ 20. In some automatic transmissions, bands are used to lock planetary components.

SECTION C. Select the best answer from the five choices listed.

____ 21. One factor in determining the service interval of automatic transmissions is

a. the size of the vehicle's tires.
b. the severity of transmission use.
c. the type of transmission fluid used.
d. the age of the transmission.
e. none of the above.

____ 22. A small amount of black deposit in the automatic transmission pan is usually the result of

a. normal wear.
b. clutch/band failure.
c. torque converter failure.
d. overheating of the fluid.
e. none of the above.

____ 23. A brown deposit (varnish in appearance) in the automatic transmission pan is usually the result of

a. normal wear.
b. clutch/band failure.
c. torque converter.
d. overheating of the fluid.
e. none of the above.

____ 24. When swirled transmission fluid looks like aluminum paint, the technician should

a. change the fluid and filter.
b. flush the system.
c. rebuild the system.
d. rebuild and flush the system.
e. do none of the above.

(NOTE: The student must obtain a minimum score of ____ on Part I the Unit IV Test in order to receive an evaluation for Competency Ee2.)

PART II. SERVICING SENSORS

SECTION A. **Read the statements below. Place a T or F in the blank each statement to indicate whether it is true or false.**

____ 25. Transmission sensors are used to control the starter circuit.

____ 26. A magnetic switch passes a coil through a stationary field.

____ 27. There are two basic types of speed sensors: magnetic pickup and hall effect.

____ 28. A multiple contact switch may have multiple in-and-out contacts and a variety of off-and-on positions.

____ 29. Grounding switches complete the circuit by providing a current path to ground when they are activated.

____ 30. Automatic transmission sensors fall into two basic categories: switches and speed sensors.

(NOTE: The student must obtain a minimum score of _____ on Part II the Unit IV Test in order to receive an evaluation for Competency Ee3.)

ANSWERS TO UNIT IV TEST

1. d
2. e
3. f
4. c
5. a
6. f
7. t
8. t
9. t
10. f
11. t
12. f
13. f
14. t
15. t
16. f
17. f
18. t
19. t
20. t
21. b
22. a
23. d
24. d
25. t
26. t
27. t
28. t
29. t
30. t

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

UNIT V: IN-VEHICLE TRANSMISSION REPAIR

UNIT OBJECTIVE

After completing this unit, the student should be able to make in-vehicle transmission/transaxle inspections and repairs. The student will demonstrate mastery of the material by achieving a score of ____ on the unit test and successfully performing specific tasks.

SPECIFIC OBJECTIVES

After completing the lessons in this unit, the student should be able to:

Lesson 1. I. Identify terms and definitions associated with in-vehicle transmission inspection and repair (Competency Ee1, Part I of the Unit V Test).

II. Identify the procedures for making in-vehicle inspections, adjustments, and repairs (Competencies Ee2, Ee3, Ee4, and Ff5, Parts II, III, IV, and VI of the Unit V Test).

III. Demonstrate the ability to:

a. Test and adjust the vacuum modulator (Competency Ee2, JS1-L1-UV).

b. Inspect and test the governor and governor cover (Competency Ee2, JS2-L1-UV).

c. Remove and replace external seals and gaskets (Competency Ee4, JS3-L1-UV).

d. Replace the extension housing and bushing (Competency Ee4, JS4-L1-UV).

e. Inspect speedometer drive assembly (Competency Ee3, JS5-L1-UV).

f. Clean, inspect, and repair valve body components (Competency Ff5, JS6-L1-UV).

g. Inspect and repair servos and accumulators (Competency Ff5, JS7-L1-UV).

Lesson 2. I. Identify the procedures for inspecting and repairing components related to the transmission (Competencies Ee2, Ee3, and Ee5, Parts II, III, and V of the Unit IV Test).

II. Demonstrate the ability to:

a. Test and flush transmission coolers (Competency Ee2, JS1-L2-UV).

b. Repair transmission cooler lines (Competency Ee2, JS2-L2-UV).

c. Test transmission solenoids and relays (Competency Ee3, JS3-L2-UV).

d. Inspect transmission mounts (Competency Ee5, JS4-L2-UV).

ASE TASKS COVERED IN THIS UNIT

I. The job sheets in this unit cover ASE tasks B012-B022.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

UNIT V: IN-VEHICLE TRANSMISSION REPAIR

CONTENTS OF THE UNIT

A. Objective sheet

B. References

C. Notes to the instructor

D. Lesson plans

1. Lesson 1: IN-VEHICLE TRANSMISSION COMPONENT TESTING,INSPECTION, AND REPAIR/ADJUSTMENT

    a. Information outline

    b. Assignment sheets

        AS1-L1-UV: In-Vehicle Transmission Component Testing
        AS2-L1-UV: Procedures for Testing and Adjusting the Vacuum Modulator
        AS3-L1-UV: Procedures for Inspecting and Testing the Governor and Governor Cover
        AS4-L1-UV: Procedures for Replacing the Extension Housing and Bushing
        AS5-L1-UV: Procedures for Cleaning, Inspecting, and Repairing Valve Body Components
        AS6-L1-UV: Procedures for Inspecting and Repairing Servos and Accumulators

    c. Job sheets

        JS1-L1-UV: Testing and Adjusting the Vacuum Modulator
        JS2-L1-UV: Inspecting and Testing the Governor and Governor Cover
        JS3-L1-UV: Removing and Replacing External Seals and Gaskets
        JS4-L1-UV: Replacing the Extension Housing and Bushing
        JS5-L1-UV: Inspecting the Speedometer Drive Assembly
        JS6-L1-UV: Cleaning, Inspecting, and Repairing Valve Body Components
        JS7-L1-UV: Inspecting and Repairing Servos and Accumulators

2. Lesson 2: IN-VEHICLE INSPECTION, ADJUSTMENT, AND REPAIR OF TRANSMISSION-RELATED COMPONENTS

    a. Information outline

    b. Assignment sheets

        AS1-L2-UV: Components Related to the Automatic Transmission
        AS2-L2-UV: Procedures for Testing and Flushing the Automatic Transmission Cooler
        AS3-L2-UV: Procedures for Repairing the Automatic Transmission Cooler Lines

AS4-L2-UV: Procedures for Testing Automatic Transmission Relays and Solenoids
AS5-L2-UV: Procedures for Inspecting and Measuring Power Train Mounts

c. Job sheets

JS1-L2-UV: Testing and Flushing Transmission Coolers
JS2-L2-UV: Repairing Transmission Cooler Lines
JS3-L2-UV: Testing Transmission Solenoids and Relays
JS4-L2-UV: Inspecting Transmission Mounts

E. Unit test

F. Answers to unit test

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Webster, Jay. Principles of Automatic Transmission. Prakken Publications, 1974.

NOTES TO THE INSTRUCTOR

A. Suggested approaches to teaching this unit

1. Students should do AS1-L1-UV and AS1-L2-UV before taking the Unit V Test. Students should do AS2-L1-UV in conjunction with JS1-L1-UV; AS3-L1-UV in conjunction with JS2-L1-UV; AS4-L1-UV in conjunction with JS4-L1-UV; AS5-L1-UV in conjunction with JS6-L1-UV; AS6-L1-UV in conjunction with JS7-L1-UV; AS2-L2-UV in conjunction with JS1-L2-UV; AS3-L2-UV in conjunction with JS2-L2-UV; AS4-L2-UV in conjunction with JS3-L2-UV; and AS5-L2-UV in conjunction with JS4-L2-UV.

2. To save time and materials, it may be desirable to have students perform two or more job sheets in this unit as one operation.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

UNIT V: IN-VEHICLE TRANSMISSION REPAIR

LESSON 1: IN-VEHICLE TRANSMISSION COMPONENT TESTING, INSPECTION, AND REPAIR/ADJUSTMENT

I. Terms and definitions

A. Angle gauge--A gauge used to measure the angle of the drive shaft in rear-wheel-drive vehicles.

B. Bushing chisel--A tool used to remove transmission bushings.

C. Bushing driver--A tool used to remove and install transmission bushings.

D. Crocus cloth--A sheet of fine, abrasive material used to polish valve body components.

E. Feeler gauge--A precision measuring device used to determine clearances between components.

F. Flat plate--A precision flat surface used for trueing and polishing spool valves.

G. Relay (electrical)--A switch used to control a large current-carrying circuit on and off.

H. Separator plate--A flat metal plate that directs and seals fluid passages. The separator plate is located between the valve body and transmission case.

I. Straightedge--A precision measuring device used to determine the flatness of transmission parts.

J. Transmission mount--Vibration-isolating device used to mount the transmission.

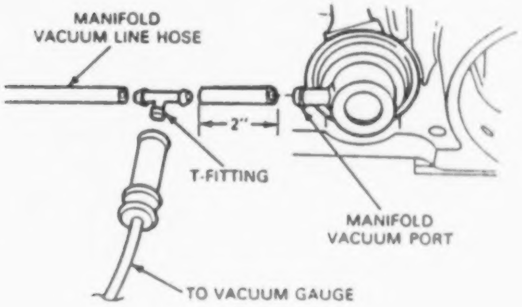
II. Making in-vehicle inspections, adjustments, and repairs

A. Procedures for inspecting, testing, and adjusting the vacuum modulator unit

(NOTE: Procedures for inspecting the vacuum modulator for fluid leaks were covered in Unit IV of the Automatic Transmission/Transaxle module. Outlined below are procedures for testing the modulator for proper operation and calibration of the return spring, both of which can affect shift quality.)

1. Modulator performance can be tested by either a manifold source test or a diaphragm vacuum test.

a. The manifold vacuum test requires that a vacuum gauge be connected to the manifold vacuum line at the modulator. When the engine is started, the gauge should register between 17 and 21 inches of vacuum. If the gauge does not give this reading, the line should be inspected for blockage, kinks, and poor connections.



DIAPHRAGM CONNECTION

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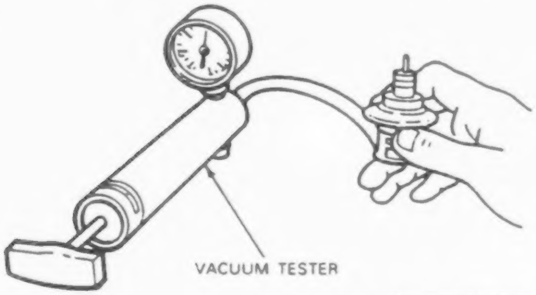
b. The diaphragm vacuum test requires the use of a hand vacuum pump. The hand pump should be attached to the modulator valve inlet and 20 inches of vacuum should be applied. The diaphragm in the modulator valve should not leak down more than 3 inches of vacuum in 2 minutes.



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2. Either the scale method or the comparison method can be used to determine the pressure of the modulator return spring.

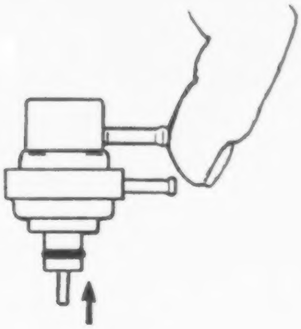
(NOTE: The scale method requires the use of a calibrated scale to measure the force exerted by the return spring as it is collapsed. Typically a weight scale with approximately a 25-pound range is used. In the procedure, a push rod [a small cylindrical rod] inside the diaphragm is used to collapse the diaphragm. Outlined below is the scale test procedure.)

a. Using the push rod, collapse the diaphragm inside the modulator.

b. Cover the vacuum port with the thumb and release the push rod pressure. Note whether the internal vacuum suspends the diaphragm.

c. Place the rod on the scale and release thumb from the vacuum port. The scale will then measure the return pressure of the spring.

(NOTE: Sometimes it is difficult to obtain specifications for the diaphragm return spring. If no specifications are available, use the comparison method instead of the scaled method.)



d. The comparison method calls for the modulator to be tested by comparing it to a modulator valve that is known to be in good condition. During the procedure, a push rod with a line scribed in its center is used. Both modulators are squeezed together. If the center mark remains in the center, the modulator being tested has spring tension equivalent to the good modulator.

3. Some vacuum modulators have an adjustable tension screw located inside the diaphragm. The adjustment is made by inserting a hex head wrench or small flat-blade screwdriver (depending on the screw head) through the vacuum inlet fitting on the modulator. Shift points can be changed by screwing the screw in or out.

B. Procedures for inspecting and repairing the governor and governor cover

1. The governor is a centrifugal sensing device that translates output shaft rpm into a hydraulic pressure signal. That signal, in turn, affects the shifting of the gear sets in order to obtain the required gear ratio.

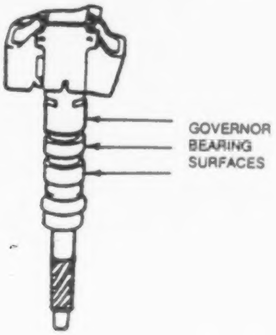
2. Procedures for testing and inspecting the governor

a. The technician should make sure that the governor's spool valves slide freely in the bore. If the valves do not slide freely, disassemble and clean the components in clean solvent. Look for scratches or varnish that could cause the spool valve to stick. If a burr or scratch is found, refer to the section on valve body parts in this unit for repair instructions.

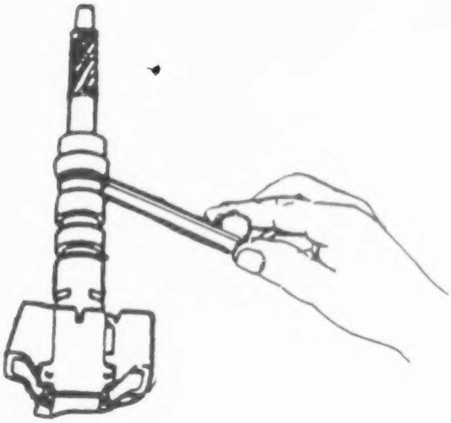
(NOTE: On some transmissions, the spool valves can be tested while the governor is assembled. Air is blown into the ports of the assembled governor. A distinct thud produced as the air forces the valve open indicates that the valve is free. Check the manufacturer's recommendations to see if the valves can be tested in this manner.)

b. Some manufacturers recommend that an oil leak down test be performed on the governor. Basically, the oil leak down test involves filling the governor port with oil and measuring the leak down rate.

c. The technician must inspect the shaft and bore surface of a governor that is case-mounted. If these surfaces become scored or have excessive clearance, hydraulic pressure will be lost, giving an inaccurate shift signal. Some manufacturers provide a replacement bushing and installation ream to restore the bore to its original size and condition.



(NOTE: Case mounted governors make it possible to measure the opening and closing gap of the spool valve in relation to the position of the flyweights. The gap can be measured with a feeler gauge.)



d. The governor's flyweights should be inspected for broken or bent pivot pins and distorted or missing return springs.

e. Most case-mounted governors are driven by a nylon gear. This gear should be inspected for missing or damaged gear teeth and for a broken shaft roll pin.

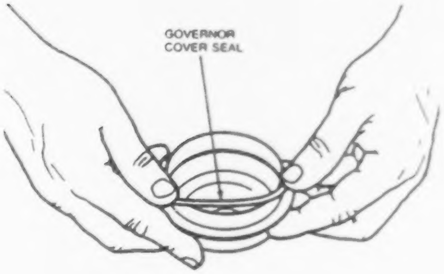
3. Procedures for repairing the governor cover

(NOTE: Little can be done to repair a severely damaged governor. There are procedures which sometimes can free sticking spool valves. These procedures can remove some valve material. If valve material is removed, leaks could occur within the governor, causing a change in the shift signal. Sometimes broken or bent governor pivot pins can be replaced. In most cases, however, a damaged or defective governor must be repaired instead of replaced.)

a. The governor case cover determines governor end thrust and provides a positive seal over the governor.

b. A case-mounted governor must be checked for a bent cover. If the cover is bent inward, it could jam the governor, thus shearing the gear teeth or the shaft roll pin. If the cover is bent outward, it could allow the governor to thrust outward enough to cause the vale ports to fall out of index, blocking the governor's signal.

c. A square-cut o-ring is used to seal the cover. When the cover is removed, a new o-ring seal should be installed. Because of the governor's location and because the governor uses a sheet metal flange to pressure the seal, it may be difficult for the o-ring to seal properly. Care should be taken to ensure full seating of the flange against the seal during installation.



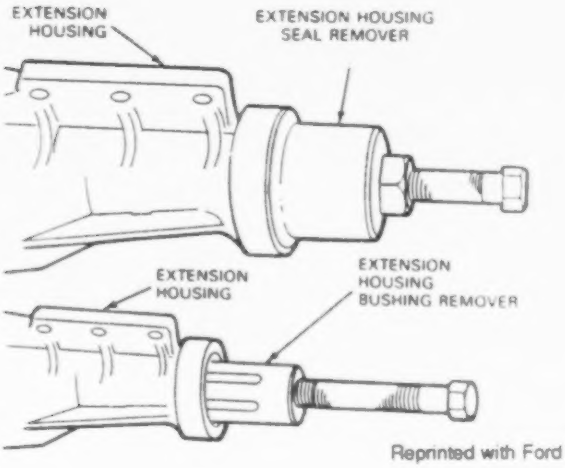
C. External seals and gaskets

1. On most automatic transmissions, two basic types of external seals are used: the lip type and compression type. For inspection procedures for these types of seals, refer to the unit on seals and fluid in this module.

2. On most automatic transmissions, three types of gaskets are used: paper, cork, and composition. Installation procedures are the same for all these three types of gaskets. During the installation of any gasket, it is important to make sure that all surfaces are clean, that positioning is correct, and that the proper torque is used. Refer to Unit IV of this module for procedures for removing pan flange dimpling.

D. Procedure for replacing an extension housing bushing and seals

1. The procedure for replacing an extension housing bushing and seals (on rear-wheel-drive vehicles) differs slightly from manufacturer to manufacturer. Care should be taken to follow the manufacturer's recommendations so that governor and speedometer parts are not damaged. Removal of the extension housing seal requires some special precautions because the case can be broken by extreme pry-bar pressure. Remove the seal by prying firmly on the inside edge of the seal.


EXTENSION HOUSING
EXTENSION HOUSING SEAL REMOVER
EXTENSION HOUSING
EXTENSION HOUSING BUSHING REMOVER

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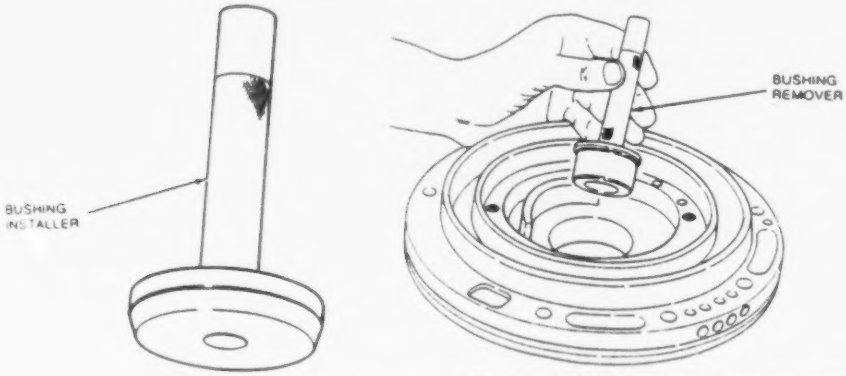
2. In order to remove a bushing, a technician must either split it with a chisel or pull it out with a bushing remover.

(NOTE: The following bushing replacement procedure applies to all large diameter bushings in the transmission.)

a. A bushing chisel is a specially designed chisel that peels a narrow piece of metal from the length of the bushing in order to split the bushing. The bushing chisel is driven parallel to the bushing bore. Care should be taken to avoid angling the chisel into the bore wall.

b. If the technician has access to both sides of the bushing, he or she should use a bushing driver to force out the bushing. A hydraulic press or a hammer can be used to apply force to the driver. The bushing driver has a centering extension, a driver shoulder, and an impact end. By locating the bushing on the centering extension, the driving shoulder can be used to force the old bushing out and the new one in.



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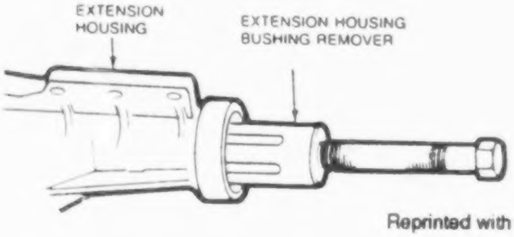
c. Blind bushings may be pulled out by using either a slide hammer puller or a screw tap.

d. The slide hammer puller consists of an expandable set of fingers that lock on the edge of the bushing. A slide hammer is screwed to the puller and the force of the hammer pulls the bushing free. A driver is used to replace the bushing.

e. A screw tap and a ball bearing can be used to pull a blind bushing that is small in diameter. A tap slightly larger than the minor diameter of the bushing is threaded into the hole. A ball bearing is dropped into the bottom of the hole to act as a thrust point for the tap. When the tap bumps the bearing, the bushing will be pushed out by the tap threads.



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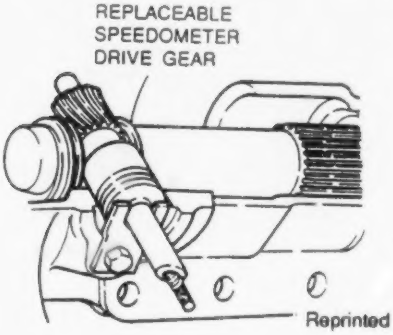
E. Inspecting and replacing speedometer drive assemblies

(NOTE: Speedometer assemblies fall into two categories: mechanical and electrical.)

1. The mechanical speedometer uses a nylon gear that has been installed on the transmission. The speedometer gear is located at the end of the speedometer cable. The speedometer cable is keyed to the cable by a square drive hole. The cable runs through a housing to the speedometer head on the instrument panel. Some different vehicle models use the same transmission design; therefore, some adjustable features are incorporated into the drive gear design. These adjustable features allow for different sizes of tires. Two basic adjustment systems are used: eccentric housing and replacement drive gear.

   a. In eccentric housing, when a change in driven gear size is called for, a replacement gear of a larger or smaller size can be installed. The eccentric housing can rotate to move the gear into contact with the drive gear. Care should be taken to index the case and housing upon installation.

   b. In order to accommodate a change in tire size, some transmissions use replaceable drive and driven speedometer gears of varying sizes. By replacing one or both gears, the transmission can accommodate different vehicle models and changes in axle and tire ratio.



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2. Electrical speedometers use electrical or electronic speed sensors which have no mechanical connection to the instrument. However, they do have drive gears that require inspection. A failure in this system would most likely occur in the electrical connection, the signal generator and processor, or the electronic speed read-out.

F. Procedure for disassembling, inspecting, repairing, and reassembling valve body components

1. Following the procedure found in the appropriate manual, disassemble and clean the valve body. Follow the recommendations outlined below.

   a. Soak and clean the valve body assembly in mineral spirits or solvent.

   b. Disassemble the valve body over a large pan to catch dropped parts.

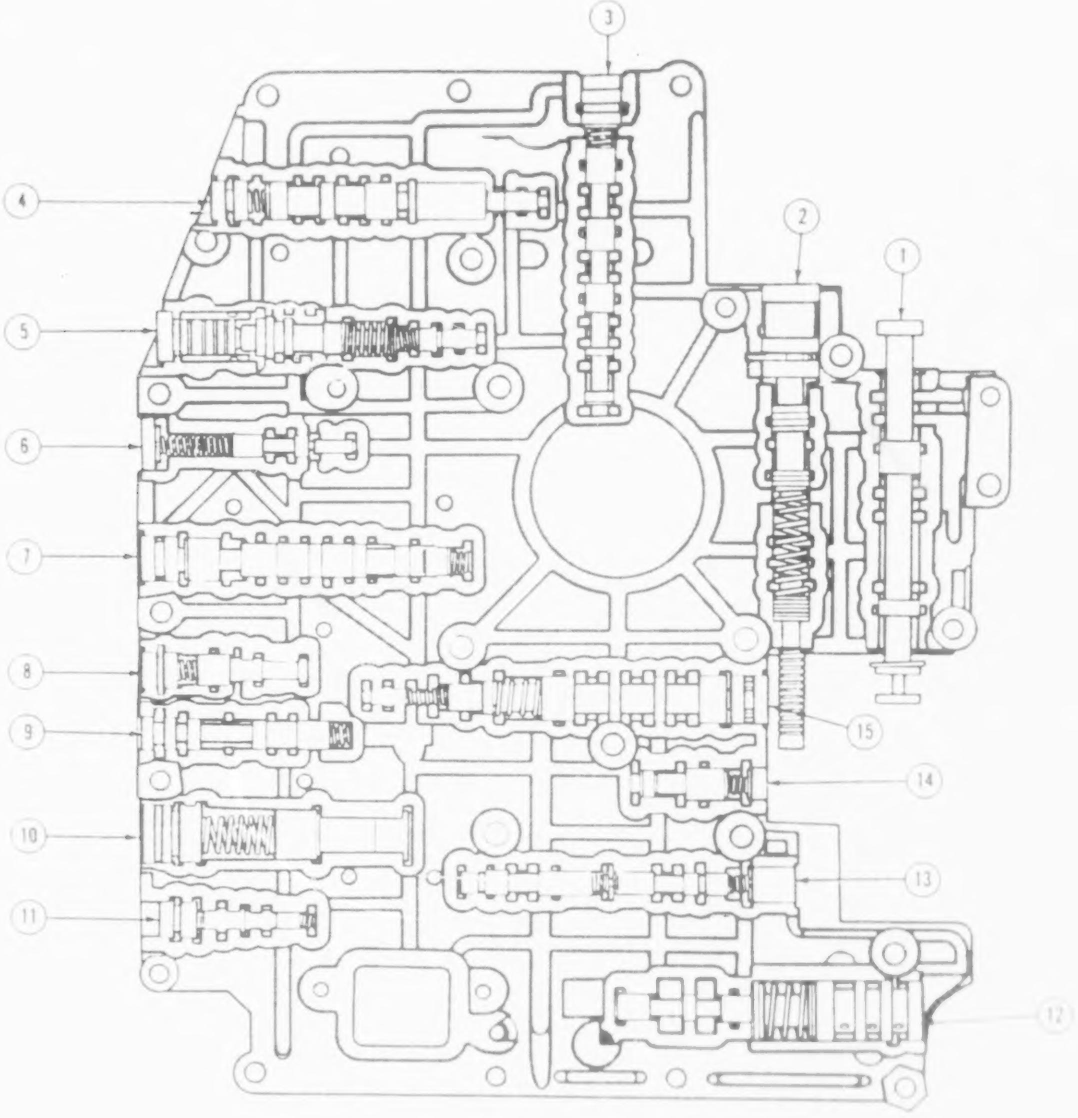
   c. Clean varnished valves with spray gum and varnish remover.

   d. Stuck valves can be removed by tapping on the side of the valve body with a plastic-tipped hammer. If this fails, use a brass or wooden pick to force the valve out from the valve body.

e. Lay out the valves, springs, and balls on a paper blotter or a paper shop towel. Do not use a cloth shop towel.

(**CAUTION**: For easier reassembly, carefully lay valves, springs, and balls out in the order in which they were removed. When laying out parts, put them in a position that relates to their location in the valve body.)

f. Flush the disassembled valve body.



ITEM	DESCRIPTION
1	MANUAL VALVE
2	THROTTLE SYSTEM VALVES
3	2-3 BACKOUT VALVE
4	ORIFICE CONTROL VALVE/2-3 CAPACITY MODULATOR VALVE (FUNCTIONS ARE SEPARATED BY A SPRING RETAINING PLATE)
5	3-4 SHIFT AND 3-4 MODULATOR VALVES
6	TV LIMIT VALVE
7	1-2 SHIFT VALVE
8	OD SERVO REGULATOR VALVE
9	3-4 SHUTTLE VALVE
10	1-2 ACCUMULATOR VALVE
11	1-2 CAPACITY MODULATOR VALVE
12	MAIN REGULATOR AND PRESSURE BOOST VALVES
13	2-1 SCHEDULING VALVE/LOW SERVO MODULATOR VALVE (FUNCTIONS ARE SEPARATED BY A SPRING RETAINING PLATE)
14	3-4 BACKOUT VALVE
15	2-3 SHIFT, 3-2 CONTROL AND 2-3 TV MODULATOR VALVES

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2. Inspect the valve body components. Blow dry the valve body. Slide each valve into its bore without the springs. The valve should slide freely in the bore without lubrication.

3. If the valve does not slide, perform the following repair.

   a. Inspect the valve for scratches or embedded metal.

   b. Inspect the bore for burrs or embedded metal.

   c. Remove any scratches, burrs, etc. by polishing the valve with fine crocus cloth. Do not round the edges of the valve.

      (NOTE: Another repair method is to lay the crocus cloth on a machinist flat plate and roll the valve across the surface of the crocus cloth.)

   d. Repair valve bores by twisting a piece of crocus cloth into a roll and inserting the cloth into the bore. Rotate the cloth in the opposite direction than it is twisted. The unrolling of the cloth will cause it to polish the sides of the bore.

   e. Repeatedly flush the valve body with solvent. Polish valves with crocus cloth and rinse them with solvent. Blow dry the components and repeat the slide test.

      (**CAUTION:** Never use emery paper or sandpaper to polish valves or bores.)

   f. Use a straightedge to check the flatness of the valve body casting.

      (NOTE: Sticking valves can be caused by valve body warping. Warping can occur when the valve body is released from its torqued position. Before rejecting a valve body for warpage, torque it in place and check for valve movement.)

4. Reassemble the valve body.

   a. Carefully observe the order of reassembly.

   b. Lubricate valves with automatic transmission fluid during assembly.

      (NOTE: Do not handle valves any longer than necessary. Warmth from hands can make the valves difficult to install.)

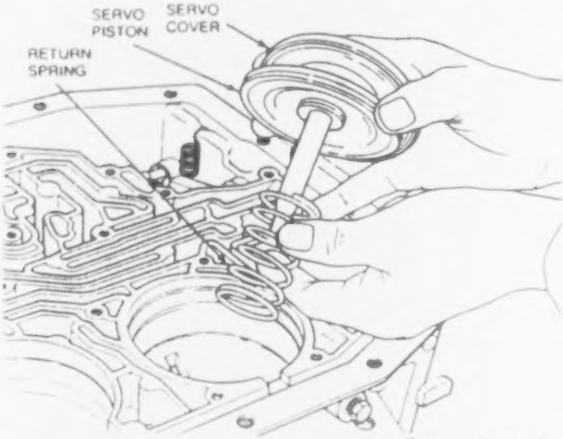
   c. If the valve body has mating parts, keep them together to prevent them from warping and sticking during assembly.

   d. Torque all screws to specification.

   e. Select the correct separator plate and gaskets and install them properly.

   f. Use petroleum jelly to hold check balls in place during assembly.

G. Servos used as band application devices will have either cast iron, teflon, or neoprene sealing rings. Occasionally the rings will score the bore wall, causing the seal to leak and the servo to bind and chatter when it is applied. Neoprene seals are sometimes molded to the servo piston. They should be inspected for separation and split sealing lips. Return springs can break or get distorted. They should be inspected for squareness and tension.



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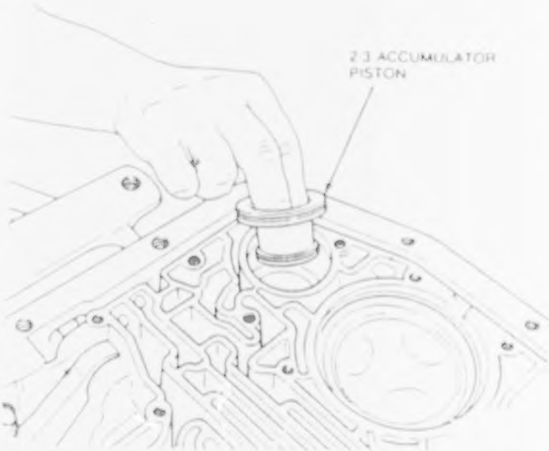
H Accumulators are similar to servos, therefore, the same inspection procedure should be used.



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MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

IN-VEHICLE TRANSMISSION COMPONENT TESTING

Instructions: **Do the following tasks and answer the following questions. Write all responses on this sheet.**

1. Define the terms listed below.

   Bushing chisel

   Bushing driver

   Crocus cloth

   Flat plate

   Separator plate

   Straightedge

2. What should modulator vacuum be at engine idle?

3. How many inches of vacuum should be applied to the vacuum modulator with hand pump in order to determine leak down rate?

4. What is the rejection time on modulator leak down?

5. What two methods can be used to determine the pressure of the modulator return spring?

6. During installation of gaskets, what three things can be done to ensure correct gasket sealing?

7. Name three methods for bushing removal.

8. Name two systems for adjusting the speed ratio of the speedometer to accommodate differences in axle ratio or tire size.

9. What device is used to check flatness of the valve body?

AS1-L1-UV

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

IN-VEHICLE TRANSMISSION COMPONENT TESTING

(ANSWER SHEET)

1. A bushing chisel is a tool used to remove transmission bushings.

   A bushing driver is a tool used to remove and install transmission bushings.

   A crocus cloth is a sheet of fine, abrasive material used to polish valve body components.

   A flat plate is a precision flat surface used for trueing and polishing spool valves.

   A separator plate is a flat metal plate that directs and seals fluid passages. The separator plate is located between the valve body and transmission case.

   A straightedge is a precision measuring device used to determine the flatness of transmission parts.

2. Between 17 and 21 inches of vacuum

3. 20 inches of vacuum

4. The diaphragm should not leak down more than 3 inches of vacuum in 2 minutes.

5. The scaled method or the comparison method

6. During the installation of any gasket, it is important to make sure that all surfaces are clean, that positioning is correct, and that the proper torque is used.

7. The bushing can either be split with a chisel or removed with a driver or a puller.

8. Eccentric housing and replacement drive gear

9. A straightedge

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

PROCEDURES FOR TESTING AND ADJUSTING THE VACUUM MODULATOR

Instructions: **Do the following tasks on a separate sheet of paper.**

(HINT: Use an appropriate service manual.)

1. Record the make, model, and year of the vehicle to be serviced.
2. Develop a written procedure for inspecting, testing a vacuum modulator. Be sure to include all necessary specifications.
3. Develop a written procedure for checking and adjusting the vacuum modulator. Be sure to include all necessary specifications.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

PROCEDURES FOR INSPECTING AND TESTING THE GOVERNOR AND GOVERNOR COVER

Instructions: Do the following tasks on a separate sheet of paper.

(HINT: Use an appropriate service manual and the information in this unit.)

1. Record the make, model, and year of the vehicle to be serviced.
2. Develop a written procedure for testing and inspecting the governor. Be sure to include instructions for inspecting the appropriate components (for example, the driven gear, the bearing surface, and the shaft roll pin) and for testing the valve movement. Also include any necessary specifications.
3. Develop a written procedure for removing and inspecting the governor cover. Be sure the procedure includes instructions for removing and cleaning the cover and seal and inspecting for distortion or denting. Also make sure the procedure includes instructions for checking the governor end trust.
4. Develop a written procedure for reinstalling the governor cover.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

PROCEDURES FOR REPLACING THE EXTENSION HOUSING AND BUSHING

Instructions: **Do the following tasks on a separate sheet of paper.**

(HINT: Use an appropriate service manual.)

1. Record the make, model, and year of the vehicle to be serviced.
2. Develop a written procedure for removing and replacing an extension housing bushing. Make sure to include all necessary specifications. Also make sure the procedure includes instructions for checking the bushing for any damage that may have occurred during installation.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

PROCEDURES FOR CLEANING, INSPECTING, AND REPAIRING VALVE BODY COMPONENTS

Instructions: **Do the following tasks on a separate sheet of paper.**

(HINT: Use an appropriate service manual.)

1. Record the make, model, and year of the vehicle to be serviced.
2. Develop a written procedure for draining the transmission fluid, removing the valve body, the pan, and the filter. Make sure to include any necessary specifications.
3. Develop a written procedure for disassembling and reassembling the valve body. Make sure to include any necessary specifications.
4. Develop a written procedure for inspecting the valve body. Make sure to include any necessary specifications.
5. Develop a written procedure for replacing the valve body, the filter, the pan, and the fluid.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

PROCEDURES FOR INSPECTING AND REPAIRING SERVOS AND ACCUMULATORS

Instructions: **Do the following tasks on a separate sheet of paper.**

(HINT: Use an appropriate service manual.)

1. Record the make, model, and year of the vehicle to be serviced.
2. Develop a written procedure for removing and replacing a servo cover and/or an accumulator. Make sure to include any necessary specifications.
3. Develop a written procedure for inspecting a servo cover and/or an accumulator.

JS1-L1-UV

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

TESTING AND ADJUSTING THE VACUUM MODULATOR

Equipment:

Safety glasses
Drain pan
Vacuum gauge
Vacuum pump
Small screwdriver or hex wrench
Hoist or jack and jack stands

Procedure:

Evaluation
3 2 1 N

1. Wear safety glasses while doing all procedures on this job sheet. ___ ___ ___ ___

2. Complete AS2-L1-UV. Following the procedure developed in item 2 of AS2-L1-UV, test the operation of the vacuum modulator. Record the condition of the modulator (make sure to record the specific readings obtained during the test). Describe any problems and suggest repairs. ___ ___ ___ ___

3. Following the procedure developed in item 3 of AS2-L1-UV, check and/or adjust the vacuum modulator. Record test results below. ___ ___ ___ ___

   (NOTE: The vehicle should be test driven to obtain shift point information. If the shift point is incorrect and no hydraulic problem is diagnosed, adjust the modulator.)

   (**CAUTION:** Before test driving the vehicle, obtain permission from the instructor.)

Average of above evaluations* ___ ___ ___ ___

(*This average is a partial evaluation for Competency Ee2. Final evaluation for Ee2 will be made at the end of JS2-L2-UV.)

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

INSPECTING AND TESTING THE GOVERNOR AND GOVERNOR COVER

Equipment:

Drain pan
Feeler gauge
Hoist or jack and jack stands
Air hose and blow gun
Safety glasses

Procedure:

	Evaluation 3 2 1 N
1. Wear safety glasses while doing all procedures on this job sheet.	___ ___ ___ ___
2. Following the procedure developed in item 2 of AS3-L1-UV, remove and inspect the governor. Record any defects in the governor or the cover.	___ ___ ___ ___
(NOTE: The extension housing or governor cover must be removed to access the governor. If defects are found, the governor will probably have to be replaced rather than repaired.)	
3. Following the procedure developed in item 3 of AS3-L1-UV, inspect the governor cover (case-mounted governors only). Record the results of the test.	___ ___ ___ ___
4. Following the procedure developed in item 4 of AS3-L1-UV, reinstall the governor cover. Replace the transmission fluid and test drive the vehicle when procedure is complete.	___ ___ ___ ___
(**CAUTION:** Always obtain the instructor's permission before test driving a vehicle.)	
Average of above evaluations.*	___ ___ ___ ___

(This average is a partial evaluation for Competency Ee2. Final evaluation for Ee2 will be made at the end of JS2-L2-UV.)

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

REMOVING AND REPLACING EXTERNAL SEALS AND GASKETS

Equipment:

Appropriate seal puller or driver
Pry bar
Safety glasses

Procedure: Evaluation 3 2 1 N

1. Wear safety glasses while doing all procedures on this job sheet. __ __ __ __

2. If a lip-type seal is used, follow the procedure outlined below to remove it. __ __ __ __

   a. Using a pry bar, lift the lip of the outer ring.

   b. Remove the seal by using one of the following procedures: 1) pry downward to lift the seal from the bore; 2) use a seal driver to push the seal from the back of the bore; 3) remove the seal with a seal puller.

   c. Use a seal driver to install the new seal.

   d. Check for leaks.

3. If a compression-type seal is used, follow the procedure outlined below to remove it. __ __ __ __

   a. Remove the seal retainer and the seal.

   b. Clean the seal area.

   c. Install a new seal.

   d. Replace the seal retainer.

   e. Check for leaks.

4. Following the procedure outlined below, replace the gasket. — — — —

   a. Remove the old gasket.

   b. Wash gasket area in solvent.

   c. Remove dimples from sheet metal flanges.

   d. Use petroleum jelly to hold new gasket in place.

   e. Reinstall cover.

   f. Check for leaks.

   Average of above evaluations* — — — —

   (This average is a partial evaluation for Competency Ee4. Final evaluation for Ee4 will be made at the end of JS4-L1-UV.)

JS4-L1-UV

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

REPLACING THE EXTENSION HOUSING AND BUSHING

Equipment:

Bushing chisel
Bushing puller
Bushing driver
Drain pan
Torque wrench
Hoist or jack and jack stands
Safety glasses

Procedure: Evaluation 3 2 1 N

1. Wear safety glasses while doing all procedures on this job sheet. — — — —

2. Complete AS4-L1-UV. Following the procedure developed in item 2 of AS4-L1-UV, remove and replace the extension housing, bushing, and seal. Replace the transmission fluid and test drive the vehicle when procedure is complete. — — — —

   (**CAUTION:** Always obtain the instructor's permission before test driving a vehicle.)

   Average of above evaluations.* — — — —

   (This average is a partial evaluation for Competency Ee4. Final evaluation for Ee4 will be made below.)

FINAL EVALUATION INSTRUCTIONS

I. Determine the student's final evaluation for Competency Ee4 by averaging the evaluations of JS3-L1-UV and JS4-L1-UV. Use the spaces provided below.

Evaluation 3 2 1 N

JS3-L1-UV — — — —

JS4-L1-UV — — — —

Final evaluation for Competency Ee4 — — — —

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

INSPECTING THE SPEEDOMETER DRIVE ASSEMBLY

Equipment:

Drain pan
Hoist or jack and jack stand
Safety glasses

Procedure:

Evaluation
3 2 1 N

1. Wear safety glasses while doing all procedures on this job sheet. __ __ __ __

2. Following the procedure outlined below, inspect the speedometer drive. __ __ __ __

   a. Index the speedometer housing.

   b. Remove the speedometer cable housing or wire harness.

   c. Remove the speedometer housing retainer.

   d. Pull the speedometer housing.

   e. Inspect the driven gear for missing teeth or a broken shaft. Record observations. Repair or replace the driven gear as needed.

   f. Inspect drive gear for missing teeth or a broken keeper. Record observations. Repair or replace drive gear as needed.

g. Install new seal.

h. Reinstall the speedometer housing to index.

i. Install retainer bolts.

Average of above evaluations* ____.

(This average is a partial evaluation for Competency Ee3. Final evaluation for Ee3 will be made at the end of JS3-L2-UV.)

JS6-L1-UV

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

CLEANING, INSPECTING, AND REPAIRING VALVE BODY COMPONENTS

Equipment:

Drain pan
Crocus cloth
Air hose and blow gun
Paper shop towel
Hoist or jack and jack stands
Brass or wooden pick
Straightedge
Torque wrench
Feeler gauge
Safety glasses

Procedure:

Evaluation
3 2 1 N

1. Wear safety glasses while doing all procedures on this job sheet. ___ ___ ___ ___

2. Complete AS5-L1-UV. Following the procedure developed in item 2 of AS5-L1-UV, drain the transmission fluid and remove the valve body, the pan, and the filter. ___ ___ ___ ___

3. Following the procedure developed in item 3 of AS5-L1-UV, disassemble the valve body. ___ ___ ___ ___

4. Following the procedure developed in item 4 of AS5-L1-UV, inspect the valve body. Record inspection results and recommend repairs or replacement. ___ ___ ___ ___

5. Following the procedure developed in item 3 of AS5-L1-UV, reassemble the valve body. ___ ___ ___ ___

6. Following the procedure developed in item 5 of AS5-L1-UV, replace the valve body. Install the filter and the pan. Add the correct amount and type of transmission fluid. Test drive the vehicle when procedure is complete. ___ ___ ___ ___

   (**CAUTION:** Always obtain the instructor's permission before test driving a vehicle.)

   Average of above evaluations.* ___ ___ ___ ___

   (This average is a partial evaluation for Competency Ff5. Final evaluation for Ff5 will be made at the end of JS2-L2-UVI.)

JS7-L1-UV

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

INSPECTING AND REPAIRING SERVOS AND ACCUMULATORS

Equipment:

Hoist or jack and jack stands
Drain pan
Safety glasses

Procedure: Evaluation 3 2 1 N

1. Wear safety glasses while doing all procedures on this job sheet. ___ ___ ___ ___

2. Complete AS6-L1-UV. Following the procedure developed in item 2 of A6-L1-UV, remove the hydraulic accumulator/servo. ___ ___ ___ ___

3. Following the procedure developed in item 3 of A6-L1-UV, inspect the hydraulic accumulator/servo. Record inspection results and recommend repairs or replacement. ___ ___ ___ ___

4. Following the procedure developed in item 2 of A6-L1-UV, replace the hydraulic accumulator/servo. Replace pan, add fluid, and test drive the vehicle when procedure is complete. ___ ___ ___ ___

Average of above evaluations.* ___ ___ ___ ___

(This average is a partial evaluation for Competency Ff5. Final evaluation for Ff5 will be made at the end of JS2-L2-UVI.)

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

UNIT V: IN-VEHICLE TRANSMISSION REPAIR

LESSON 2: IN-VEHICLE INSPECTION, ADJUSTMENT, AND REPAIR OF TRANSMISSION-RELATED COMPONENTS

I. Inspecting and repairing components related to the transmission

(NOTE: The below procedures deal with components that are external to the transmission. These components are usually serviced or repaired while the transmission is still in the vehicle. The service and repair procedures outlined below are not a part of standard transmission service. These procedures may have to be performed, however, to prevent transmission malfunctions.)

A. Inspecting, testing, flushing, and repairing the cooler and its lines and fittings

1. Procedure for testing and inspecting the cooler

(NOTE: Many transmission coolers are located inside the radiator. If transmission fluid is contaminated with antifreeze or if the antifreeze is contaminated with automatic transmission fluid, the technician should inspect and pressure test the cooler for leaks.)

a. Remove both cooler lines and plug one.

b. Connect an air hose with a pressure regulator to the open end.

c. Pressurize the cooler to between 25 and 50 psi.

(**CAUTION:** Be careful not to exceed 50 psi. Excessive pressure can rupture a good cooler.)

d. Observe the radiator coolant for air bubbles. The presence of bubbles indicates a leaking cooler.

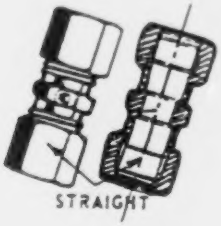
2. When the torque converter fails, it fills the hydraulic system with very fine metallic flakes. These flakes cause the fluid to resemble aluminum paint. If metallic flakes are present, the entire transmission will have to be overhauled and the cooler and lines will have to be flushed. The technician can either pressure flush the cooler or remove and clean the radiator.

a. Pressure flushing involves flushing both the cooler and its lines. Pressure flushing usually does not clean the cooler as well as boiling and flushing the radiator; however, if pressure flushing is done long enough, it will clean sufficiently. A pressure flusher is simply a container with a hand pump that pressurizes the container. By filling the container with solvent and sending the solvent (under pressure) through the cooler and its lines, the contamination from the converter can be dislodged. Be sure to capture the outflow of solvent from the cooler lines.

b. The best method for cleaning a cooler located within a radiator is to remove the radiator and boil it out. This not only removes the cooler's contamination but cleans the radiator as well. The cooler lines should be removed and flushed with solvent and air.

3. The transmission cooler may operate at up to 50 psi. To contain this pressure, cooler lines must be made of steel tubing. Cooler lines can fail as a result of external abrasion or kinking. If cost allows, damaged lines should be replaced. However, if the damage is not too extensive, repair the damaged area with a steel union.

a. Steel unions are available for brake lines, but they also work well for transmission lines. The procedure for adding a steel union to a brake line involves splitting the line at the defective area, double flaring the line, and then installing the union. Steel unions provide a strong, permanent repair.



b. If line damage occurs at a bend in the line or in an area at which a steel union cannot be added, the best repair method is to replace the entire line. However, if line replacement is not practical, the line can be split at the defective area and a piece of high-pressure hose can be attached to the end of each steel line. The high-pressure hose should extend at least two inches past both sides of the split. Standard clamps should be used to tighten the hose on the lines. Cable ties or metal line clips should be used on both ends of the repair to prevent the lines from backing out of the hose.

(NOTE: Using a high-pressure hose to repair cooler lines is a temporary repair only.)

(NOTE: A low-pressure fuel line is not strong enough to be used in cooler line repairs.)

B. Testing transmission solenoids and relays

1. Many automatic transmissions use electrically activated solenoids to control hydraulic activity. The solenoid is a simple magnetic coil device that can be either internally or externally grounded. Standard electrical test procedures are used to test solenoid operation.

a. An internally grounded solenoid can be tested for opens, shorts, and proper grounds. The test involves testing with a VOM or DVOM in the ohms scale.

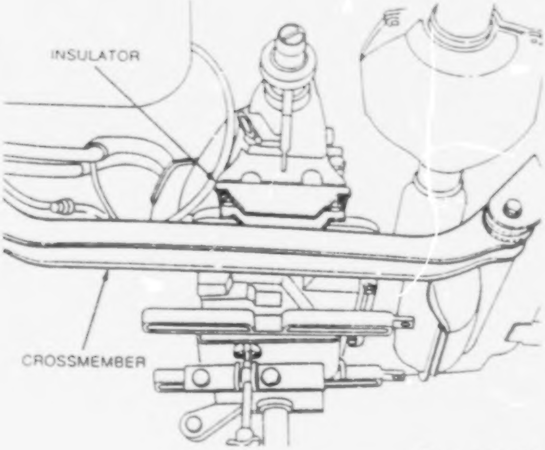
b. Externally grounded solenoids are basically the same as the internally grounded solenoid, with the exception that the solenoid achieves ground at a point away from the transmission. Externally grounded solenoids are tested in much the same way as internally grounded solenoids.

2. Some solenoids within automatic transmissions must be activated with heavy current flow. It is not necessary that the control circuit for the solenoid be constructed as heavy as the load circuit of the solenoid. A relay provides a good way to use a low amperage circuit to control a heavy load solenoid circuit. The relay is a basic magnetic coil which acts upon a set of moveable contact points that switch the solenoid circuit off and on. Testing involves measuring the electrical coil's ability to carry current and the contact's ability to relay heavy current.

C. Engine and transmissions are suspended on rubber isolating mounts that absorb vibration and power train noise.

1. Inspecting and measuring alignment of rear-wheel-drive transmission mounts

a. Most vehicles have three different mounts: two engine mounts and a single transmission mount. The engine mounts can be tested by brake torquing the engine forward and backward. If a mount is broken, the engine will lift and visibly separate from the mount. The transmission mounts must be lifted and observed for separation. By placing the vehicle on a hoist, the mechanic can vertically lift the extension housing if the mount is separated. The extension housing will lift from the mount.



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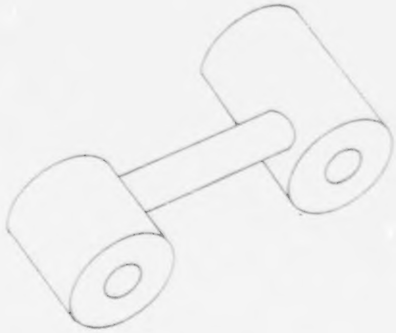
b. Some drive lines have adjustable mounts to compensate for variations in drive lines. An angle gauge can be used to measure the angle of the drive shaft. Adjustment procedures vary from model to model.

2. Inspecting and measuring the alignment of front-wheel-drive mounts

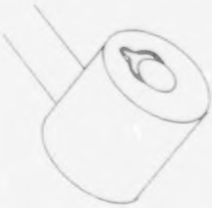
   a. Front-wheel-drive mounts not only suspend the engine and transaxle but also locate the assembly left to right and absorb the torque wrap-up of the engine from front to back. The suspension mounts are located on the left and right of the engine and transaxle. They have slotted mounting holes, which allow for minor adjustments in position. The ability to adjust position allows for equal distribution of half the shaft length from side to side. If adjusted improperly, the C-V joints will undergo undue compression or extension, which will cause them to fail prematurely.

   b. The front to back engine mount is sometimes called a "torque strut" because it absorbs the forward and backward movement of the engine and transaxle during acceleration or deceleration. This forward and backward movement of the engine is called torque wrap-up.

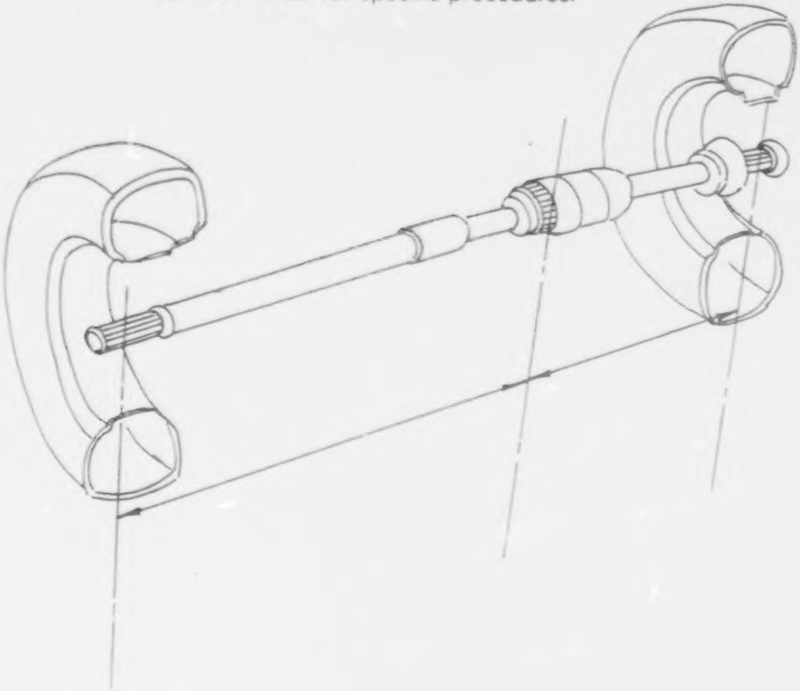


   c. Front-wheel-drive transaxle and engine mounts can be inspected in much the same way as rear-wheel-drive transmission mounts. When the weight of the assembly is lifted from the mount, look for looseness or separation of the rubber from the metal.

   d. If the rubber bushing is loose on the mount bolt of the torque strut, the strut is defective. An additional check can be made by brake torquing the engine forward and backward. This will force the engine back and forth against the strut. If the bushing is bad, there will be a noticeable cling or thumping in the mount.



e. Procedures for centering front-wheel-drive mounts vary, depending on the vehicle manufacturer. On some vehicles, the drive shaft hub nuts must be loosened and the C-V joints bottomed. Then the amount of shaft thread that extends from the hub can be measured, and the mounts can be adjusted until they are equal. Other vehicles require different centering procedures. All centering procedures are designed to achieve sufficient length clearance to allow for changes in suspension geometry. Consult the service manual for specific procedures.



MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

COMPONENTS RELATED TO THE AUTOMATIC TRANSMISSION

Instructions: **Do the following tasks and answer the following questions. Write all responses on this sheet.**

1. What is the purpose of an angle gauge?

2. Describe the procedure for pressure testing a transmission cooler.

3. What is the maximum pressure at which a cooler should be pressure tested?

4. Name two methods for cleaning transmission coolers.

5. Besides replacement, briefly describe two methods for repairing cooler lines.

6. What devices are used to test solenoids in an automatic transmission?

7. Describe the procedure for identifying a broken motor mount on a rear-wheel-drive vehicle.

8. Describe the function of a torque strut on a front-wheel-drive vehicle.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

COMPONENTS RELATED TO THE AUTOMATIC TRANSMISSION

(ANSWER SHEET)

1. An angle gauge can be used to measure the angle of the drive shaft.

2. Remove both cooler lines and plug one. Connect an air hose with a pressure regulator to the open end. Pressurize the cooler to between 25 and 50 psi. Observe the radiator coolant for air bubbles.

3. 59 psi

4. The cooler can be cleaned by either pressure flushing or removing and cleaning the radiator.

5. Cooler lines can be repaired with either steel unions or high-pressure hoses.

6. Solenoids are tested with a VOM or DVOM in ohms scale.

7. If a mount is broken, the engine will lift and visibly separate from the mount. The transmission mounts must be lifted and observed for separation. By placing the vehicle on a hoist, the mechanic can vertically lift the extension housing if the mount is separated. The extension housing will lift from the mount.

8. The torque strut (which is the front-to-back engine mount on front-wheel-drive vehicles) absorbs the forward and backward movement of the engine and transaxle during acceleration or deceleration.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

PROCEDURES FOR TESTING AND FLUSHING THE AUTOMATIC TRANSMISSION COOLER

Instructions: **Do the following tasks on a separate sheet of paper.**

(HINT: Use an appropriate service manual.)

1. Record the make, model, and year of the vehicle to be serviced.
2. Develop a written procedure for testing the automatic transmission cooler.
3. Develop a written procedure for flushing the automatic transmission cooler.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

PROCEDURES FOR REPAIRING THE AUTOMATIC TRANSMISSION COOLER LINES

Instructions: **Do the following tasks on a separate sheet of paper.**

(HINT: Use an appropriate service manual.)

1. Record the make, model, and year of the vehicle to be serviced.
2. Develop a written procedure for repairing automatic transmission cooler lines with a steel union. Include all necessary specifications.
3. Develop a written procedure for repairing automatic transmission cooler lines with a high-pressure hose. Include all necessary specifications.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

PROCEDURES FOR TESTING AUTOMATIC TRANSMISSION RELAYS AND SOLENOIDS

Instructions: **Do the following tasks on a separate sheet of paper.**

(HINT: Use an appropriate service manual.)

1. Record the make, model, and year of the vehicle to be serviced.
2. Develop a written procedure for testing transmission relays and solenoids. Include all necessary specifications.

   (NOTE: For further information concerning electrical tests, refer to the Electrical Systems module.)

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

PROCEDURES FOR INSPECTING AND MEASURING POWER TRAIN MOUNTS

Instructions: **Do the following tasks on a separate sheet of paper.**

(HINT: Use an appropriate service manual.)

1. Record the make, model, and year of the vehicle to be serviced.
2. Develop a written procedure for the inspection and measurement of power train mounts on a rear-wheel-drive vehicle. Include all necessary specifications.
3. Develop a written procedure for the inspection and measurement of power train mounts on a front-wheel-drive vehicle. Include all necessary specifications.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

TESTING AND FLUSHING TRANSMISSION COOLERS

Equipment:

Connecting air fittings or
Soft tip blow gun
Air hose and pressure regulator
Radiator cleaning equipment and supplies
Hoist or jack and jack stands
Drain pan
Safety glasses

Procedure:	Evaluation 3 2 1 N
1. Wear safety glasses while doing all procedures on this job sheet.	__ __ __ __
2. Complete AS2-L2-UV. Following the procedure developed in item 2 of AS2-L2-UV, test the transmission cooler. Record observations.	
3. Following the procedure developed in item 3 of AS2-L2-UV, flush the automatic transmission cooler.	__ __ __ __
Average of above evaluations*	__ __ __ __

(This average is a partial evaluation for Competency Ee2. Final evaluation for Ee2 will be made at the end of JS2-L2-UV.)

JS2-L2-UV

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

REPAIRING TRANSMISSION COOLER LINES

Equipment:

Tubing cutter
Double flare tool
Steel union
Drain line
Hoist or jack and jack stands
Safety glasses

Evaluation
3 2 1 N

Procedure:

1. Wear safety glasses while doing all procedures on this job sheet. ___ ___ ___ ___

2. Complete AS3-L2-UV. Following the procedure developed in item 2 of AS3-L2-UV and the steps outlined below, use a steel union to repair a leaking cooler line. ___ ___ ___ ___

    a. Cut cooler line at the damaged area and capture lost fluid.

    b. Install a flare nut on each tube end.

    c. Double flare each line.

    d. Install a union.

    e. Test for leaks. Record the test results below.

    f. Top off fluid.

3. Following the procedure developed in item 3 of AS3-L2-UV, use a high-power hose to repair a leaking cooler line. ___ ___ ___ ___

    a. Cut line at damaged area and capture lost fluid.

    b. Slide the hose on each end of the cooler line at 2" each side.

    c. Clamp hose to line on each end about 1/4" from the end of the hose.

       (NOTE: The steel line should almost meet in the middle of the hose.)

    d. Tie each end of the cable to either side of the hose in order to surround support with cable ties or metal line clamps.

e. Test for leaks. Record the test results below.

f. Top off fluid.

Average of above evaluations* __ __ __ __

(*This average is a partial evaluation for Competency Ee2. Final evaluation for Ee2 will be made at the end of this job sheet.)

FINAL EVALUATION INSTRUCTIONS

I. Determine the student's final evaluation for Competency Ee2 by averaging the evaluations of JS1-L1-UIV, JS2-L1-UIV, JS3-L1-UIV, JS1-L1-UV, JS2-L1-UV, JS1-L2-UV, and JS2-L2-UV. Use the spaces provided below.

	Evaluation			
	3	2	1	N
JS1-L1-UIV	___	___	___	___
JS2-L1-UIV	___	___	___	___
JS3-L1-UIV	___	___	___	___
JS1-L1-UV	___	___	___	___
JS2-L1-UV	___	___	___	___
JS1-L2-UV	___	___	___	___
JS2-L2-UV	___	___	___	___
Final evaluation for Competency Ee2	___	___	___	___

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

TESTING TRANSMISSION SOLENOIDS AND RELAYS

Equipment:

VOM or DVOM
Safety glasses

Procedure:

Evaluation
3 2 1 N

1. Wear safety glasses while doing all procedures on this job sheet. __ __ __ __

2. Complete AS4-L2-UV. Following the procedure developed in item 2 of AS4-L2-UV and the steps outlined below, test the transmission solenoid and/or relay. __ __ __ __

   Basic steps for testing a solenoid:

   a. Select ohms scale Rx1 or 200 ohms.

   b. Connect and lead to solenoid and wire.

   c. Connect and lead to ground or to wire, depending on style of solenoid.

   d. If coil is good, reading should be close to zero but not zero. Record test results below.

   Basic steps for testing a relay:

   e. Select ohms scale RX1 or 200 ohms.

   f. Connect and lead to relay coil terminal.

   g. Connect and lead to ground or to wire.

   h. Reading should be less than infinite but more than zero. Record the results of the test below.

(NOTE: For further information concerning electrical tests, refer to the Electrical Systems module.)

Average of above evaluations* ___ ___ ___ ___

(*This average is a partial evaluation for Competency Ee3. Final evaluation for Ee3 will be made below.)

FINAL EVALUATION INSTRUCTIONS

I. Determine the student's final evaluation for Competency Ee3 by averaging the evaluations of JS4-L1-UIV, JS5-L1-UV, and JS3-L2-UV. Use the spaces provided below.

	Evaluation 3	2	1	N
JS4-L1-UIV	___	___	___	___
JS5-L1-UV	___	___	___	___
JS3-L2-UV	___	___	___	___
Final evaluation for Ee3	___	___	___	___

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

INSPECTING TRANSMISSION MOUNTS

Equipment:

Hoist or jack and jack stands
Angle gauge (optional)
Safety glasses

Procedure:

		Evaluation 3 2 1 N
1.	Wear safety glasses while doing all procedures on this job sheet.	__ __ __ __
2.	Complete AS5-L2-UV. Following the procedure developed in item 2 of AS5-L2-UV and the steps listed below, inspect the transmission mounts on a rear-wheel-drive vehicle.	__ __ __ __

a. Safely lift vehicle, using the proper equipment.

b. Inspect mount bolts for tightness. Record observations.

c. Lift extension housing up and down to look for mount separation or looseness. Record observations.

d. If the drive line has suffered frequent universal joint failure or unusual vibration, measure the drive shaft angle. Record measurements below.

e. Install angle gauge on drive shaft and calibrate the gauge.

f. Obtain manufacturer's specification from the service manual.

g. Compare angle reading to the specification. Record the results of the comparison.

h. If the angle reading is not within specifications, consult the service manual to determine what corrective action will adjust angle to specification. Record the proper corrective action below.

i. Lower vehicle.

j. Start engine. Put vehicle in drive with foot brake applied.

k. Lightly accelerate and observe for excessive engine torque rocking. Record observations.

l. Put transmission in reverse. Repeat light acceleration. Record observations.

(NOTE: Excessive torque rocking indicates the possibility of a separated engine mount.)

2. Following the procedure developed in item 3 of AS5-L2-UV and the steps outlined below, inspect the transmission mounts on a front-wheel-drive vehicle. ____

   a. Obtain manufacturer's procedure for centering the transaxle.

   b. Inspect left and right mounts for separation, splitting, or looseness. Record observations.

   c. Center the transaxle (according to the manufacturer's procedure). Adjust as necessary.

   d. Inspect the torque strut for loose bushing or bolts.

   e. Start engine and engage in drive.

   f. Lightly accelerate. Observe for excessive torque wrap-up. Record observations.

   g. Engage transmission in reverse. Repeat light acceleration. Record observations.

      (NOTE: A thump or clunk may be heard if the torque strut bushing is loose.)

Average of above evaluations* ____

(*This average is the final evaluation for Competency Ee5.)

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

UNIT V: IN-VEHICLE TRANSMISSION REPAIR

UNIT V TEST

PART I. TRANSMISSION COMPONENTS

SECTION A. Match the following terms with their appropriate definitions.

____ 1. A precision measuring device used to determine clearances between components.

____ 2. A tool used to remove transmission bushings.

____ 3. A precision flat surface used for trueing and polishing spool valves.

____ 4. A sheet of fine, abrasive material used to polish valve body components.

____ 5. Located between the valve body and transmission, a flat metal plate that directs and seals fluid passages.

a. crocus cloth

b. feeler gauge

c. flat plate

d. separator plate

e. bushing chisel

(NOTE: The student must obtain a minimum score of _____ on Part I of the Unit V Test in order to receive an evaluation for Competency Ee1.)

PART II. DIAGNOSING AND REPAIRING THE TRANSMISSION/TRANSAXLE

SECTION A. Read the statements below. Place a T or F beside each statement to indicate whether it is true or false.

____ 6. There should be no transmission fluid in the vacuum modulator line.

____ 7. Vacuum modulator calibration can affect shift quality.

____ 8. An engine at idle should produce 10 to 15 inches of vacuum.

____ 9. The vacuum modulator diaphragm should hold vacuum indefinitely.

____ 10. Modulator springs can be checked by using a vacuum gauge.

____ 11. In most cases, defective governors are replaced and not repaired.

____ 12. In some cases, the governor cover determines the end thrust of the governor.

____ 13. When the governor cover is removed, a new seal should always be installed.

____ 14. Pressure flushing is the only way to clean a transmission cooler.

____ 15. Fuel line hoses can be used to repair transmission cooler lines.

SECTION B. Select the best answer from the five choices listed.

____ 16. Some vacuum modulators can be adjusted with

a. a hammer.
b. a screwdriver.
c. a torque wrench.
d. a nut driver.
e. an air wrench.

____ 17. The governor is inspected for

a. proper valve operation.
b. adequate vacuum.
c. carbon buildup.
d. proper tilt.
e. none of the above.

____ 18. Excessive clearance between the governor and bearing will cause

a. sticking governor weights.
b. loss of low gear only.
c. loss of intermediate gear only.
d. loss of high gear only.
e. incorrect shift signals.

____ 19. The gear that drives the governor is inspected for all but

a. a broken roll pin.
b. worn teeth.
c. broken teeth.
d. teeth clearance.
e. all of the above.

____ 20. Never pressurize the transmission cooler above

a. 25 pounds.
b. 50 pounds.
c. 75 pounds.
d. 100 pounds.
e. 150 pounds.

(NOTE: The student must obtain a minimum score of _____ on Part II of the Unit V Test in order to receive an evaluation for Competency Ee2.)

PART III. INSPECTING, ADJUSTING, AND REPLACING SENSORS AND CABLES

SECTION A. Read the statements below. Place a T or F beside each statement to indicate whether it is true or false.

____ 21. Speedometer drives are classified as magnetic and hall effect.

____ 22. Tire size affects speedometer readings.

____ 23. Speedometer drive gears can be changed to correct speedometer error.

____ 24. Before the speedometer drive gear is removed, the housing should be indexed.

____ 25. An electronic speedometer uses no drive gears.

____ 26. The solenoid is a simple mechanical device.

____ 27. Solenoids are checked for open, grounded, and shorted circuits.

____ 28. Relays work in a manner similar to solenoids.

____ 29. Solenoids are used to control high amperage circuits with low amperage.

____ 30. The procedures for testing relays and solenoids are similar.

(NOTE: The student must obtain a minimum score of _____ on Part III of the Unit V Test in order to receive an evaluation for Competency Ee3.)

PART IV. INSPECTING AND REPLACING INTERNAL BUSHINGS, SEALS, AND GASKETS

SECTION A. **Read the statements below. Place a T or F beside each statement to indicate whether it is true or false.**

____ 31. Automatic transmissions use three types of external seals.

____ 32. Lip seals are often made of cork.

____ 33. Gasket mating surfaces must be cleaned to prevent leaks.

____ 34. Caution must be used when removing the extension housing seal with a pry bar because the housing could be broken.

____ 35. There are two methods for removing transmission bushings.

____ 36. A slide hammer is often used to remove blind bushings.

____ 37. A screw tap is used to cut threads on bushings.

____ 38. Hydraulic presses are often used to install bushings.

____ 39. A cold chisel is used to split bushings prior to removal.

____ 40. Lip seals are used between the extension housing and the transmission case.

(NOTE: The student must obtain a minimum score of _____ on Part IV of the Unit V Test in order to receive an evaluation for Competency Ee4.)

PART V. INSPECTING, REPLACING, AND ALIGNING POWER TRAIN MOUNTS

SECTION A. **Read the statements below. Place a T or F beside each statement to indicate whether it is true or false.**

____ 41. Rear-wheel-drive vehicles usually use three mounts.

____ 42. If a mount is broken on a rear-wheel-drive vehicle, the engine will lift and visibly separate from the mount during torque braking.

____ 43. Some transmission mounts are adjustable.

____ 44. The angle gauge is used to check front-wheel drive axles.

____ 45. Front-wheel-drive transmissions have no mounts.

____ 46. If defective, torque struts will make a clunking sound during acceleration and deceleration.

____ 47. The torque strut is used to center the CV joints.

____ 48. If a four-wheel-drive transmission is not centered, the CV joints will quickly be destroyed.

____ 49. Transmission mounts cannot separate a brake.

____ 50. Rubber mounts are used to absorb vibration and power train noise.

(NOTE: The student must obtain a minimum score of _____ on Part V of the Unit V Test in order to receive an evaluation for Competency Ee5.)

PART VI. REASSEMBLING AUTOMATIC TRANSMISSION COMPONENTS

SECTION A. Read the statements below. Place a T or F beside each statement to indicate whether it is true or false.

____ 51. Valve body parts are soaked and cleaned in gasoline.

____ 52. Stuck valves can be removed from the valve body with a wooden pick.

____ 53. Always lay valve body components on a shop towel to prevent damage.

____ 54. When valves are dry, they should slide freely in valve body bores.

____ 55. Servo and accumulators are inspected in much the same manner.

SECTION B. Select the best answer from the five choices listed.

____ 56. To deburr valve body bores, the technician should use

a. emery cloth.
b. sand paper.
c. crocus cloth.
d. a hand ream.
e. none of the above.

____ 57. A straightedge is used to check

a. valve body flatness.
b. transmission case flatness.
c. the cleanliness of the valve body.
d. separator plate flatness.
e. all of the above.

____ 58. The best lubricant for holding spool valves in place is

a. solvent.
b. automatic transmission fluid.
c. motor oil.
d. lithium grease.
e. power steering fluid.

____ 59. A chattering servo can be caused by

a. a leaking cast iron seal.
b. a leaking teflon seal.
c. a leaking neoprene seal.
d. a scored servo bore.
e. all of the above.

____ 60. During assembly of the valve body,

a. torque specifications should be followed.
b. springs may be interchanged.
c. valves may be interchanged.
d. check balls should be held in place with spring clips.
e. none of the above should be done.

(NOTE: The student must obtain a minimum score of _____ on Part VI of the Unit V Test in order to receive an evaluation for Competency Ff5.)

ANSWERS TO UNIT V TEST

1. b
2. e
3. c
4. a
5. d
6. t
7. t
8. f
9. f
10. f
11. t
12. t
13. t
14. t
15. f
16. b
17. a
18. e
19. d
20. b
21. f
22. t
23. t
24. t
25. t
26. f
27. t
28. t
29. t
30. t
31. f
32. f
33. t
34. t
35. t
36. t
37. f
38. f
39. f
40. f
41. t
42. t
43. t
44. f
45. f
46. t
47. f
48. f
49. f
50. t
51. f
52. t
53. f
54. t
55. t
56. c
57. e
58. b
59. d
60. a

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

UNIT VI: OFF-CAR TRANSMISSION REPAIR

UNIT OBJECTIVE

After completing this unit, the student should be able to describe and perform off-car related repair. The student will demonstrate mastery of the material by achieving a score of ____ on the unit test and successfully performing specific tasks.

SPECIFIC OBJECTIVES

After completing the lessons in this unit, the student should be able to:

Lesson 1.

I. Identify terms and definitions associated with off-car transmission repair (Competency Ff1, Part I of the Unit VI Test).

II. Identify the procedures for removing a rear-wheel-drive transmission (Competency Ff1, Part I of the Unit VI Test).

III. Identify the procedures for disassembling a transmission (Competencies Ff1 and Ff5, Parts I and V of the Unit VI Test).

IV. Identify the procedures for cleaning and inspecting transmission units (Competencies Ff2, Ff3, and Ff4, Parts II, III, and IV of the Unit VI Test).

V. Identify the procedures for removing front-wheel-drive transaxle assemblies (Competency Ff1, Part I of the Unit VI Test).

VI. Identify the procedures for disassembling an automatic transaxle unit (Competencies Ff1 and Ff5, Parts I and V of the Unit VI Test).

VII. Identify the procedures for cleaning and inspecting transaxle assemblies (Competencies Ff2, Ff3, and Ff4, Parts II, III, and IV of the Unit VI Test).

VIII. Identify the procedures for inspecting, repairing, and testing the oil pump and torque converter (Competency Ff2, Part II of the Unit VI Test).

IX. Identify the procedures for inspecting and repairing gear train components (Competency Ff3, Part III of the Unit VI Test).

X. Identify the procedures for inspecting, repairing, and testing friction and reaction units (Competency Ff4, Part IV of the Unit VI Test).

XI. Identify the procedures for installing the transaxle (Competency Ff1, Part I of the Unit VI Test).

XII. Demonstrate the ability to:

   a. Remove a rear-wheel-drive automatic transmission (Competency Ff1, JS1-L1-UVI).

   b. Disassemble a rear-wheel-drive automatic transmission (Competency Ff1, JS2-L1-UVI).

   c. Clean and inspect a rear-wheel-drive transmission (Competency Ff1, JS3-L1-UVI).

   d. Remove a front-wheel-drive transaxle (Competency Ff1, JS4-L1-UVI).

   e. Disassemble a front-wheel-drive transaxle (Competency Ff1, JS5-L1-UVI).

   f. Clean and inspect a front-wheel-drive transaxle (Competency Ff1, JS6-L1-UVI).

   g. Disassemble and inspect an automatic transmission pump (Competency Ff2, JS7-L1-UVI).

   h. Inspect and service the torque converter and flex plate (Competency Ff2, JS8-L1-UVI).

   i. Inspect the gear train (Competency Ff3, JS9-L1-UVI).

   j. Inspect, repair, and test friction and reaction units (Competency Ff4, JS10-L1-UVI).

Lesson 2.

I. Identify the procedures for reassembling transmission units (Competency Ff5, Part V of the Unit VI Test).

II. Identify the procedures for reinstalling the transmission (Competency Ff1, Part I of the Unit VI Test).

III. Identify the procedures for assembling an automatic transaxle (Competency Ff5, Part V of the Unit VI Test).

IV. Identify the procedures for installing a transaxle (Competency Ff1, Part I of the Unit VI Test).

V. Demonstrate the ability to:

   a. Reassemble a rear-wheel-drive automatic transmission (Competency Ff5, JS1-L2-UVI).

   b. Reassemble a transaxle (Competency Ff5, JS2-L2-UVI).

   c. Air test the operation of clutch packs and servo assemblies (Competency Ff4, JS3-L2-UVI).

   d. Reinstall a rear-wheel-drive automatic transmission (Competency Ff1, JS4-L2-UVI).

   e. Reinstall a transaxle (Competency Ff1, JS5-L2-UVI).

ASE TASKS COVERED IN THIS UNIT

I. The job sheets in this unit cover ASE tasks B023-B048.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

UNIT VI: OFF-CAR TRANSMISSION REPAIR

CONTENTS OF THIS UNIT

A. Objective sheet

B. References

C. Notes to the instructor

D. Lesson plans

1. Lesson 1: REMOVING, DISASSEMBLING, INSPECTING, REASSEMBLING, AND INSTALLING TRANSMISSION/TRANSAXLE

    a. Information outline

    b. Assignment sheets

    AS1-L1-UVI: Procedures for Removing a Rear-Wheel-Drive Automatic Transmission
    AS2-L1-UVI: Procedures for Disassembling a Rear-Wheel-Drive Automatic Transmission
    AS3-L1-UVI: Procedures for Removing a Front-Wheel-Drive Transaxle
    AS4-L1-UVI: Procedures for Disassembling a Front-Wheel-Drive Transaxle
    AS5-L1-UVI: Procedures for Disassembling and Inspecting an Automatic Transmission Pump
    AS6-L1-UVI: Procedures for Disassembling a Front-Wheel-Drive Transaxle
    AS7-L1-UVI: Procedures for Inspecting the Gear Train
    AS8-L1-UVI: Procedures for Inspecting, Repairing, and Testing Friction and Reaction Units

    c. Job sheets

    JS1-L1-UVI: Removing a Rear-Wheel-Drive Automatic Transmission
    JS2-L1-UVI: Disassembling a Rear-Wheel-Drive Automatic Transmission
    JS3-L1-UVI: Cleaning and Inspecting a Rear-Wheel-Drive Transmission
    JS4-L1-UVI: Removing a Front-Wheel-Drive Transaxle
    JS5-L1-UVI: Disassembling a Front-Wheel-Drive Transaxle
    JS6-L1-UVI: Cleaning and Inspecting a Front-Wheel-Drive Transaxle
    JS7-L1-UVI: Disassembling and Inspecting an Automatic Transmission Pump
    JS8-L1-UVI: Inspecting and Servicing the Torque Converter and Flex Plate
    JS9-L1-UVI: Inspecting the Gear Train
    JS10-L1-UVI: Inspecting, Repairing, and Testing Friction and Reaction Units

2. Lesson 2: SUBUNIT INSPECTION, REPAIR, AND TESTING

    a. Information outline

b. Assignment sheet

AS1-L2-UVI: Procedures for Reassembling a Rear-Wheel-Drive Automatic Transmission
AS2-L2-UVI: Procedures for Reassembling a Transaxle
AS3-L2-UVI: Procedures for Air Testing the Operation of Clutch Packs and Servo Assemblies
AS4-L2-UVI: Procedures for Reinstalling a Rear-Wheel-Drive Automatic Transmission
AS5-L2-UVI: Procedures for Reinstalling a Transaxle

c. Job sheets

JS1-L2-UVI: Reassembling a Rear-Wheel-Drive Automatic Transmission
JS2-L2-UVI: Reassembling a Transaxle
JS3-L2-UVI: Air Testing the Operation of Clutch Packs and Servo Assemblies
JS4-L2-UVI: Reinstalling a Rear-Wheel-Drive Transmission
JS5-L2-UVI: Reinstalling a Transaxle

E. Unit test

F. Answers to unit test

REFERENCES

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NOTES TO THE INSTRUCTOR

A. Suggested approaches to teaching this unit

1. Students should do AS1-L1-UVI in conjunction with JS1-L1-UVI; AS2-L1-UVI in conjunction with JS2-L1-UVI; AS3-L1-UVI in conjunction with JS4-L1-UVI; AS4-L1-UVI in conjunction with JS5-L1-UVI; AS5-L1-UVI in conjunction with JS7-L1-UVI; AS6-L1-UVI in conjunction with JS8-L1-UVI; AS7-L1-UVI in conjunction with JS9-L1-UVI; and AS8-L1-UVI in conjunction with JS10-L1-UVI. Students also should do AS1-L2-UVI in conjunction with JS1-L2-UVI; AS2-L2-UVI in conjunction with JS2-L2-UVI; AS3-L2-UVI in conjunction with JS3-L2-UVI; AS4-L2-UVI in conjunction with JS4-L2-UVI; and AS5-L2-UVI in conjunction with JS5-L2-UVI.

B. Suggested audio-visual material from The Media Center, State Fair Community College, Sedalia, Mo.

1. Axle Bearing and Seal Replacement (AM-84-452), 1984.
2. Final Drive Adjustments (AM-84-453), 1984.
3. Automatic Transaxle Removal, Disassembly, and Inspection (AM-86-600), 1986.
4. Reassembly and Installation of Automatic Transaxle (AM-86-601), 1986.
5. Servicing and Repair of Front-Wheel Drive Axles (AM-86-602), 1986.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

UNIT VI: OFF-CAR TRANSMISSION REPAIR

LESSON 1: REMOVING, DISASSEMBLING, INSPECTING,TESTING. AND REPAIRING TRANSMISSION/TRANSAXLE

I. Terms and definitions

A. Cleaning agent--A chemical concentrate mixed with water and used in jet washers or steam cleaners to remove dirt from transmission cases and other components.

B. Clutch spring compressor--A mechanical device used to collapse the return springs on friction clutch assemblies.

C. Dial indicator--A precision measuring device used to measure clearances between components.

D. Drive link chain--A multiple link chain used to transfer rotational torque from the transmission portion of a transaxle to the final drive components.

E. End play--The axial clearance distance between the bearing and race or a thrust washer and a component.

F. Flex plate--A metal plate that connects the torque converter to the end of the crankshaft.

G. Jet cleaner--A transmission cleaning device that sprays chemical agents under high pressure to remove dirt and sludge from transmission components.

H. Parking pawl--A locking mechanism that engages a slotted wheel on the transmission output shaft. A parking pawl is used to prevent a vehicle from rolling while the vehicle is in park.

I. Preload--A pretensioning of bearings to bearing races. Preload ensures zero axial clearance without undue pressure on the bearing. Preload is usually measured by torque effort.

J. Shims--Clearance absorbing devices that are used to set bearing preload.

K. Steam cleaner--A cleaning device which uses a chemical agent, high pressure steam, and heat to remove dirt and sludge from transmission components.

L. Thrust washer--A metal or nylon washer that eliminates clearance between transmission gear elements and absorbs axial thrust during the linear transfer of engine torque.

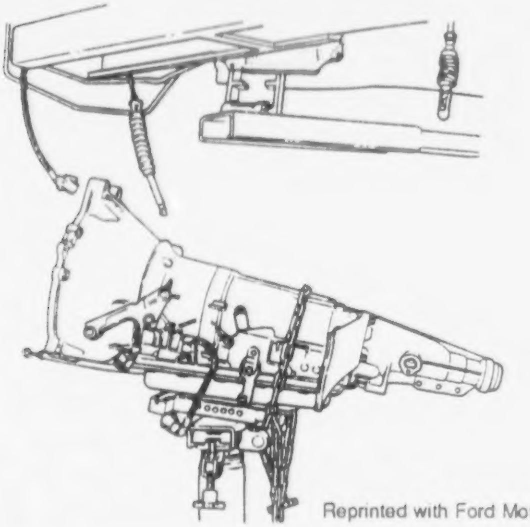
M. Torque converter flusher--A device that forces solvent into a torque converter and pump for the purpose of cleaning.

II. Removing a rear-wheel-drive transmission

A. Transmission removal equipment

1. The transmission jack is a type of floor jack. When completely lowered, some floor transmission jack will lie almost flat and very close to the floor. A transmission jack is either mechanically or hydraulically operated. A mounting fixture on transmission jacks allows them to be adjusted to a variety of transmission designs. A safety chain should be used around the transmission when the transmission is being raised or lowered.

2. The hoist jack is used on vehicles that are on a hoist. The hoist jack is usually a hydraulic device with a foot-operated pump and controls. The hoist jack has a mounting fixture that allows the hoist jack to be adjusted to a variety of transmissions. Use the safety chain when raising or lowering the transmission.



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3. Transmission cooler lines can trickle fluid for a long time after they are disconnected. The lines should be plugged with vinyl or rubber plugs.

B. Tips and precautions for removing a transmission

1. Always wear safety glasses when working under a vehicle. Disconnect the battery ground cable.

2. Be sure to raise the vehicle high enough to allow the transmission adequate space for proper clearance and support.

3. If possible, drain the fluid from the transmission to avoid spills.

4. When removing the drive shaft, wrap the rear u-joint with tape so it will not come apart. Mark the location of the u-joint on the differential yoke, and plug the opening to the transmission.

5. Many components external to the transmission will have to be disconnected during transmission removal. Each manufacturer has different methods for connecting external components to the transmission. Do not attempt to remove components without knowing exactly how they are attached. Some examples of external components are listed below.

   a. Speedometer sensing device (mechanical or electrical)

   b. Manual linkage

      (NOTE: When removing a manual linkage, be sure not to lose any related hardware.) .

   c. Wiring connections

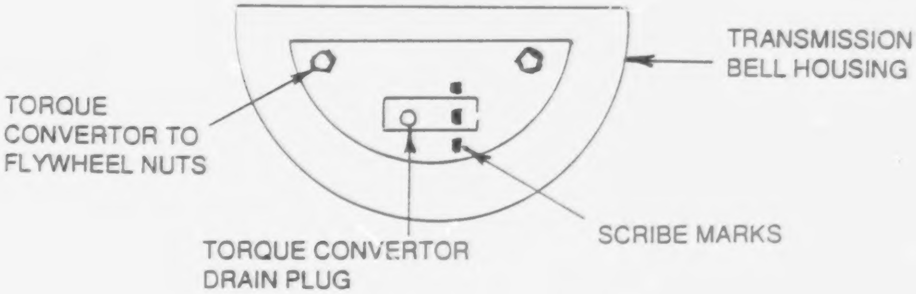
   d. Cooler lines (double wrench and plug after removal)

   e. Throttle valve or detent linkage or cable

   f. Vacuum lines and support clips

   g. Bell housing covers

6. In order to remove the torque converter, the technician must remove the bolts or nuts that hold the converter to the flex plate. In order to access these bolts, the technician will have to rotate the crank pulley or the flywheel ring manually. Index the location of the torque converter to the flex plate with a punch mark.


TRANSMISSION BELL HOUSING
TORQUE CONVERTOR TO FLYWHEEL NUTS
SCRIBE MARKS
TORQUE CONVERTOR DRAIN PLUG

7. The transmission support fixture mounts to the transmission jack and will have to be adjusted to fit the transmission being removed. Always use a safety chain over the transmission to hold the transmission on the jack.

8. Some vehicles have engine parts that will have to be disconnected before the transmission is removed. Some examples of these engine parts are listed below.

   a. Starters

   b. Exhaust system components

   c. Distributors

    d. Emergency brake cables

9. On some vehicles, the weight of the engine and transmission must be supported during the removal of the crossmember. This is done by either installing a support bar above the engine or placing a jack under the oil pan.

10. Examine the transmission mount for separation when it is removed.

11. While the transmission is raised, the upper bell housing bolts may be difficult to reach. Lowering the transmission and engine slightly in the rear may allow for easier access.

III. Procedures for disassembling a transmission

(NOTE: Disassembly procedure for automatic transmissions differ significantly, depending on the type of transmission being serviced. The following procedures are merely general steps and not intended to be followed as specific steps of procedure. Always refer to the proper manual for specific procedures.)

(NOTE: In the below information, the term "unit" refers to the transmission as a completely assembled component.)

A. Measure gear train end play according to the procedure outlined below.

(NOTE: The internal gear sets use thrust washers to space the gear sets. Thrust washers also provide a low-friction surface to control the thrust of the input shaft and gear train. Most manufacturers require that the gear train and end play clearance be measured before transmission is disassembled. Based upon this measurement, the technician can choose a thrust washer that will compensate for long-term wear in all of the thrust washers. Compensating thrust washers are available in various thicknesses. Compensating thrust washers are commonly called "selective thrust washers.")

1. Remove the torque converter. Grasp the converter with both hands and pull it straight off the input and pump housing. To prevent fluid leakage, quickly rotate the pump drive hub to an upright position.

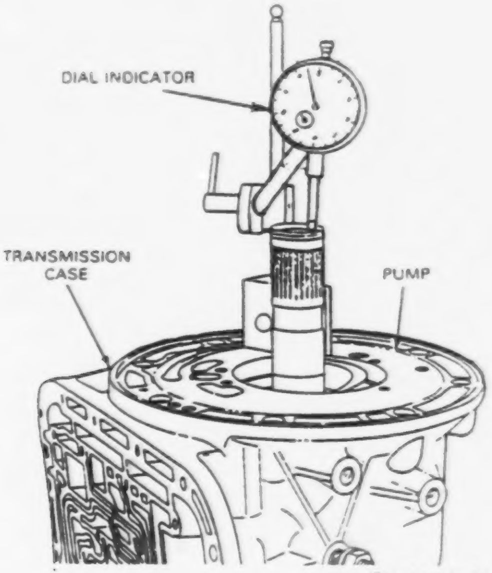
2. Mount the transmission on a suitable holding fixture or stand.

3. Attach a dial indicator stand off to the bell housing or a stud screwed into a bolt hole of the pump.

4. Attach the dial indicator to the standoff.

5. Force the input shaft back into the transmission. On transmissions mounted vertically, the input shaft will already be seated.

6. Adjust the dial indicator stylus to touch the input shaft perpendicularly to the face of shaft. Zero the dial.



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7. Lift or push the input shaft out. Record the shaft travel as indicated by the dial movement.

8. Remove the indicator and stand.

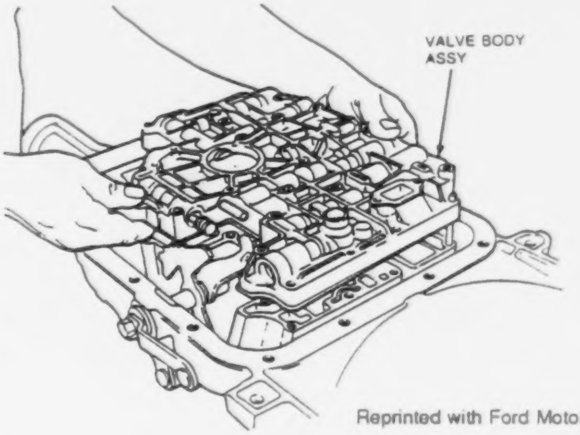
B. Following the procedure outlined below, remove the transmission subassemblies.

1. Remove the transmission pan.

(NOTE: After removing the pan, the technician should examine the pan's sediment residue.)

2. Remove the valve body. Watch for ball checks, springs, or linkage parts during removal.

   (NOTE: During valve body removal, note the length of the bolts so they can be put in the proper places during reassembly.)



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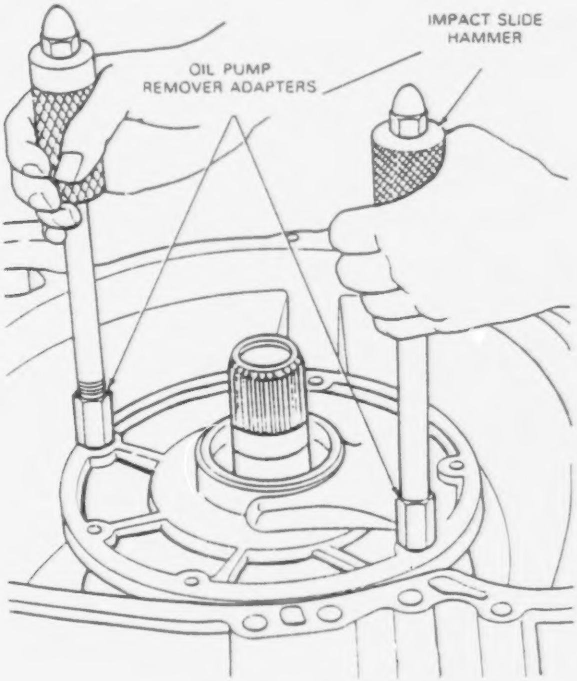
3. Remove the extension housing. Be careful not to damage other parts and components.

4. Remove the pump assembly. Either the slide hammer method or the pry bar method is used to remove the pump assembly.

   (NOTE: The slide hammer method requires that two of the bolt holes through the pump housing be threaded. By screwing slide hammer bolts into the holes, a pair of hammers can be used to pull the pump from the transmission case.)



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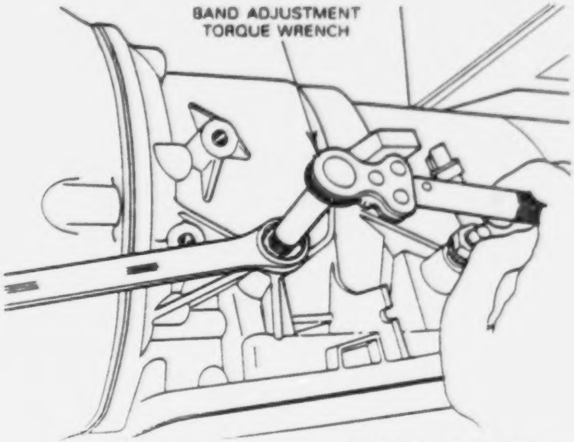
(NOTE: Some manufacturers do not provide threaded holes in the pump housing. The pry bar method must then be used to pry the clutch units apart, thus pushing the pump from the housing.)

5. Loosen band adjusters, if applicable.

(NOTE: On some transmissions, the band struts will have to be removed before the bands can be loosened. In such cases, a servo apply device is also required to loosen the band. Observe the order of the strut sizes between front and rear bands to ensure proper placement during reassembly.)



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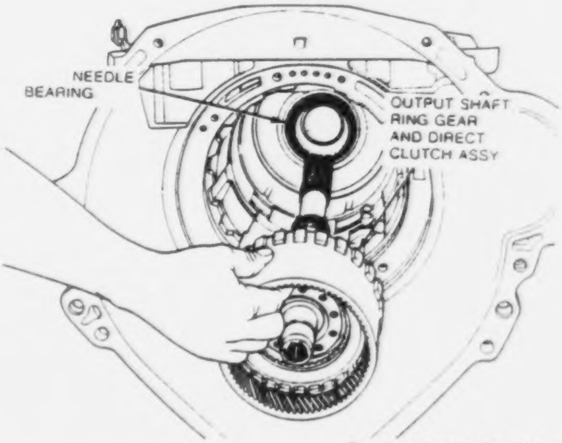
6. Lift or pull input shaft and clutch assemblies. Note the thrust washer positions.

7. Remove planetary gear sets. Note thrust washer position. The planetary gear sets may have internal retainer or snap rings that will require removal for disassembly.



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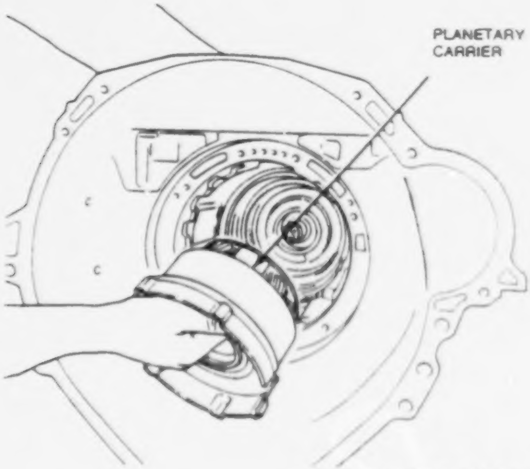
8. Remove any additional clutches if required.

9. Remove output shaft. Depending on the transmission design, the output shaft can come out from either the front or rear of the transmission.



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IV. Cleaning and inspecting transmission units

A. Cleaning transmission units

1. The internal units of the transmission such as valve body, clutch and drum assemblies, pumps, etc., should be rinsed in clean solvent and set aside for rebuilding.

2. The transmission case can be cleaned by using either a solvent tank, a jet cleaner, or a steam cleaner.

   a. Using the solvent tank is the slowest and most difficult method of cleaning the transmission case. The case is simply put into a large solvent tank and scrubbed by hand with a cleaning brush.

   b. A jet cleaner is a cabinet that holds the case. Once the case is in the cabinet, high-pressure cleaning jets remove all dirt. A jet cleaner usually has some kind of filter or sediment tank to remove dirt from the cleaning fluid so that fluid can be used again.

   c. The steam cleaner uses a continuous water supply and a cleaning agent tank. In the tank, a cleaning solution is mixed with water before it enters the steam cleaner pump. The pump forces the water and cleaning agent into a steam coil, where it is boiled. The solution then goes through a high-pressure hose and nozzle, where it removes the accumulated dirt from the case.

B. Procedures for inspecting a transmission case

(NOTE: The transmission case must withstand vibration, torque, and high pressures. The case must, therefore, be inspected for cracks, porosity, bushing failure, clogged vents, and warped mating surfaces. The case can easily be inspected after it is cleaned.)

1. Inspect the case for cracks in the following areas: bell housing, pump mounting surface, extension housing, manual shaft bushing, valve body mating surface, servo bores or mounts, band anchor pins, and clutch lugs.

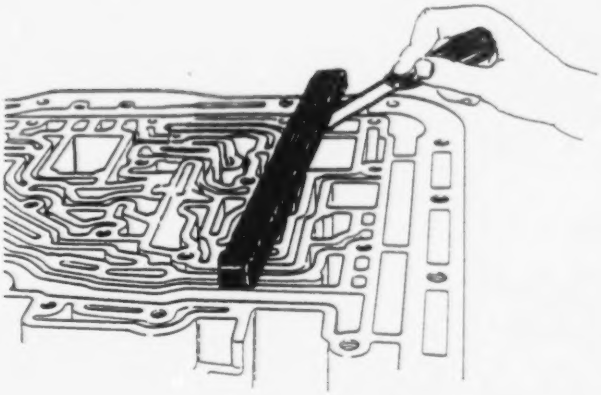
2. Inspect the case for casing porosity in the following areas: valve body, servos, accumulator, pump passages, and governor passages.

   (NOTE: some manufacturers have developed a procedure for using epoxy cement to repair porosity. Consult the service manual.)

3. Inspect the case for bushing or bore failure. Inspect all bores or bushings for scoring, cracking, or excessive wear. Some bores can be repaired by reaming the hole to the proper replacement size. Consult the service manual for possible repair options.

4. Inspect transmission vents. Vents can be plugged with road dirt, which prevents the blow-off of casing pressure. Oil blowing from the dipstick or from the seals indicates clogged transmission vents.

5. Inspect the case for warped mating surfaces. Use a straightedge to check the flatness of the following areas: valve body, servos, extension housing, and oil pan. Problems such as improper hydraulic system operation or leaking fluid indicate warped mating surfaces.

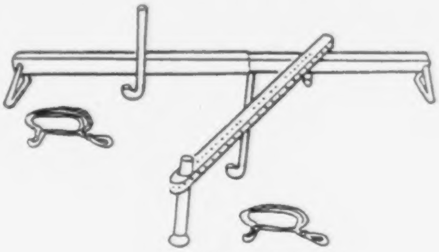


V. Removing front-wheel-drive transaxle assemblies

(NOTE: Procedures for servicing transmission are much like those for servicing transaxle. To avoid repetition, the transaxle section refers to the transmission section for some procedures. Before performing a transaxle overhaul, the student should study the transmission lesson.)

(NOTE: Some transaxles cannot be removed from the vehicle without also removing the engine. This lesson will deal only with transaxles that can be removed without removing the engine.)

A. Transaxle removal equipment is similar to transmission removal equipment. However, transaxle removal does require some unique jacks and holding fixtures. Transaxle removal also requires an adjustable engine support, consisting of hangers and a cross bar. When the transaxle is removed from the vehicle, one side of the engine is left without a mount; therefore, the engine support is used to hold the engine.



ENGINE SUPPORT BAR

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B. Procedure for removing an automatic transaxle

1. Disconnect the negative battery cable. Doing so prevents accidental engagement of the starter and shorted cables.
2. Disconnect the following transaxle related components: speedometer (mechanical or electrical), cooler lines (be sure to plug lines upon removal), associated wires, and throttle/detent linkage cable.
3. Safely lift the vehicle on a hoist or jack stands. If a hoist is used, the vehicle's tires must be allowed to swing free.
4. Drain the fluid.
5. Remove front wheels. Label the position of each wheel.
6. Disconnect the half shafts from the transaxle (remove as needed).
7. Install the engine support fixture.
8. Remove the transaxle mounts.
9. Remove the engine, the exhaust, and suspension components that are blocking transaxle removal.
10. Install transmission jack and engine support bar.
11. Mark the converter and remove the mounting bolts.

12. Remove the bell housing bolts.

13. Move the transaxle away from the engine slightly.

14. Lower the transaxle from the vehicle.

(NOTE: Some manufacturers use special holding pins on the differential side gears to prevent their being dislodged and dropped into the final drive case.)

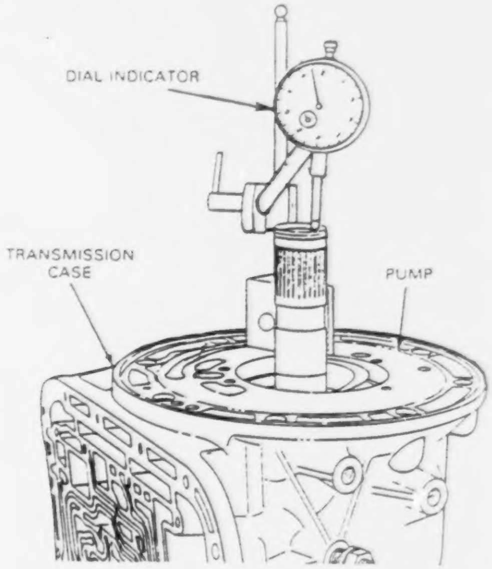
VI. Procedures for disassembling an automatic transaxle unit

(NOTE: Procedures for disassembling an automatic transaxle differ significantly, depending on the vehicle model. The below procedure is general and is intended merely to provide a general idea of how an automatic transaxle should be disassembled. Consult the proper service manual for specific disassembly procedures.)

A. Remove the torque converter.

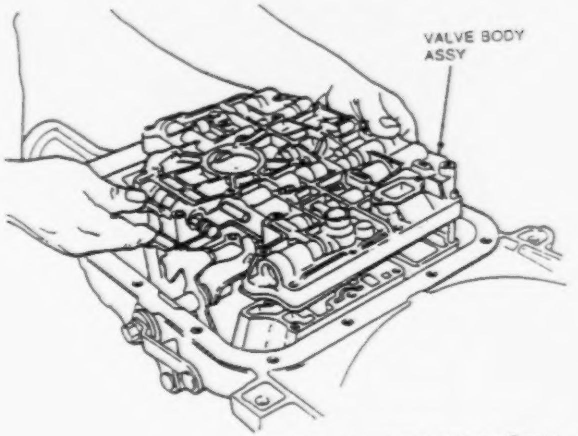
B. Mount the transaxle on a suitable holding fixture.

C. Measure end play.



D. Remove fluid pan. Examine the sediment in the pan.

E. Remove the valve body.


VALVE BODY
ASSY

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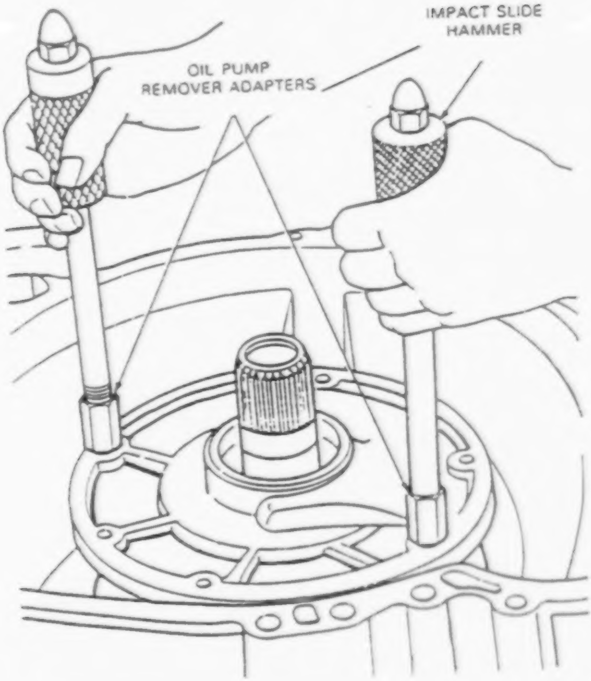
F. Remove the governor.

G. Remove the pump.


IMPACT SLIDE
HAMMER
OIL PUMP
REMOVER ADAPTERS

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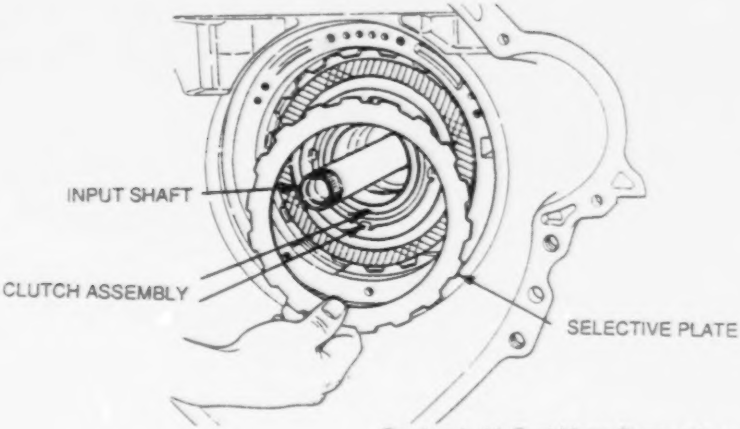
H. Remove the input shaft and clutches.


INPUT SHAFT
CLUTCH ASSEMBLY
SELECTIVE PLATE

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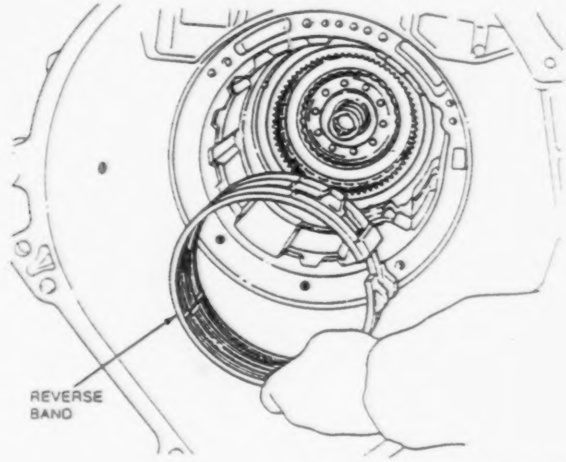
I. Loosen the band adjusting screws.

J. Remove the bands, drums, and servos.


REVERSE BAND

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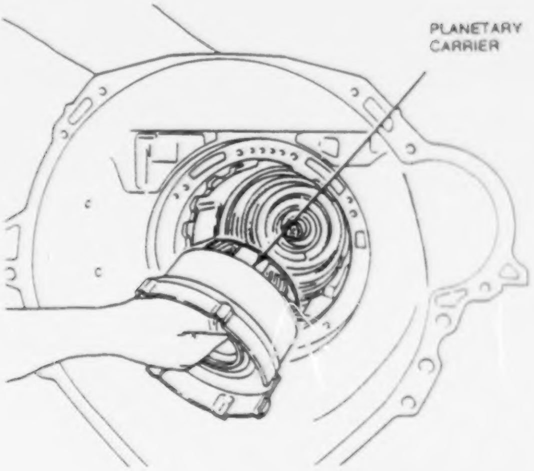
K. Remove the planetary gear assembly.



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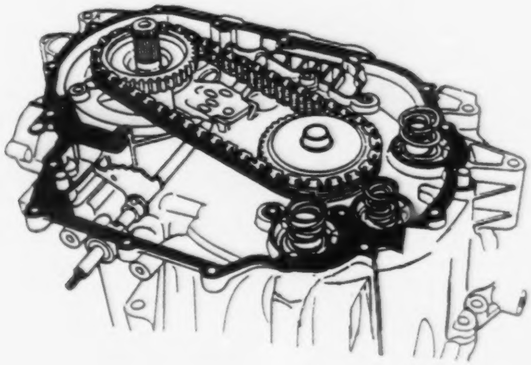
L. Remove the rear cover. The transfer system may be driven by a gear or by a chain and sprocket. Some manufacturers require a clearance or chain tension, which should be checked at this point.



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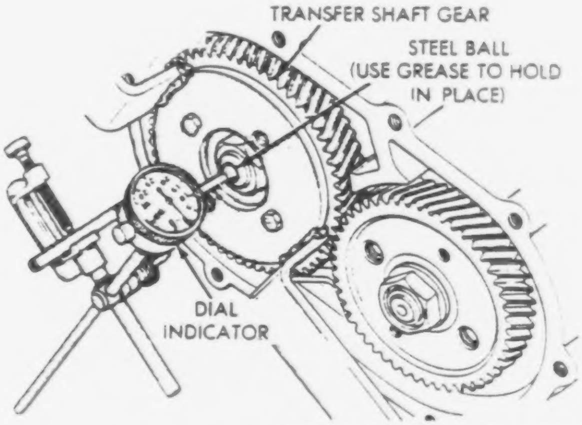
M. Measure and record shaft end play. Remove shaft retaining nuts or sprockets. A special tool may be required to hold the gear or sprocket while the nuts are removed.



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N. Following the procedure outlined below, disassemble final drive.

(NOTE: The final drive needs to be disassembled only when final drive failure is suspected.)

1. Remove final drive cover.
2. Measure and record final drive side bearing end play.
3. Remove differential bearing retainer.
4. Remove the differential assembly.

VII. Cleaning and inspecting transaxle assemblies

A. Clean the internal transaxle components.

(NOTE: Internal transaxle components should be cleaned in the same manner as internal transmission components.)

B. Clean the transaxle case. If the final drive has not been removed, the case should be flushed with solvent only; the transaxle case should not be steam or jet cleaned if the final drive has not been removed. If the final drive has been removed, the transaxle case can be steam or jet cleaned in the same manner as a transmission case.

C. Inspect the transaxle case for the problems listed below.

(NOTE: The transaxle case should be inspected in the same manner as a transmission case.)

1. Cracking around transfer shaft housing
2. Cracking in the final drive housing
3. Cracking in the differential bearing retainers

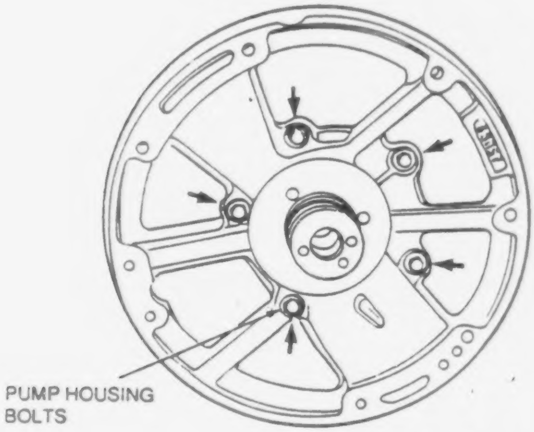
4. Deterioration of the transaxle mount

5. Failure of the bores and bushing

VIII. Inspecting, repairing, and testing the oil pump and torque converter

A. Disassembling, inspecting, and reassembling oil pump

1. Disassembling most transmission pumps involves removing bolts, bushings, and oil sealing rings. Bolts hold the cast iron pump body to a cast iron cover. When these bolts are removed, the cover can be removed from the body. When the body is removed, the gears, vanes, or rotors are exposed, thus allowing for measurement. Several shaft support bushings and oil sealing rings should also be removed during disassembly. A hollow stator support shaft may also extend out of the front of the pump.



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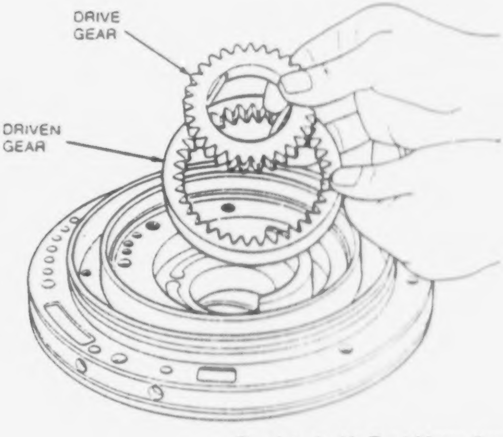
2. Various pump components should be inspected as described below.

a. The pump gears, lobes, or vanes should be inspected for excessive wear.

(NOTE: The pump housing should be inspected for galling, wear or cracking in the gear area. The inner and outer gear should be inspected for scoring or obvious wear. On vane pumps, the vane rotor and vanes should be inspected for the same problems.)



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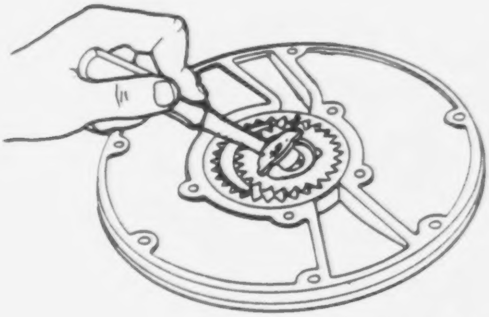
b. During the inspection, pump clearance should be measured with a feeler gauge and straightedge. Excessive clearance can be detected by measuring the clearance between the outer gear and the pump body and between the gear face and the pump body. Excessive clearance results in low pump discharge pressure.



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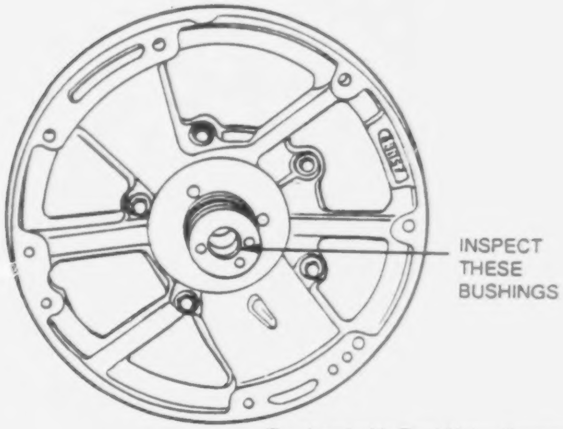
c. The stator support shaft may have as many as three bushings. Check to see if the bushings are concentric. A worn bushing will appear to be egg shaped. Bushings also can be loose in the support shaft.



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d. Any spool valves in the pump housing should be inspected according to the procedure recommended by the manufacturer.

e. Most transmission pumps contain three seals: the converter seal, the outer pump seal, and the pump-to-case gasket. These seals should be inspected and serviced in the same manner as lip, compression, and gasket seals.

(NOTE: Variable displacement pumps have some additional inspection requirements).

B. Servicing and inspecting torque converter

1. The torque converter requires occasional service and cleaning during rebuilds. Two basic methods exist: flushing and draining.

a. A converter should be removed before being flushed. After removal, a special hydraulic device called a flusher is used to force a cleaning solvent into the converter and then pulls the solvent back out by rotating the converter at high speeds. After flushing, a small charge of automatic transmission fluid is left in the converter.

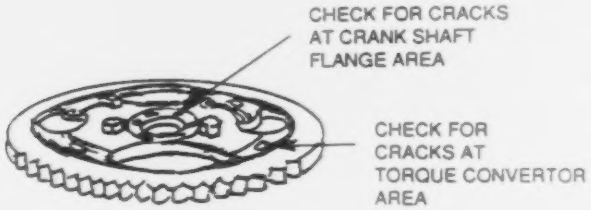
b. Some torque converters can be drained by removing a draining plug built into the converter. A hole must be drilled in other converters in order for them to be drained.

(NOTE: When fluid is drained through the plug, no cleaning takes place. The old oil can be replaced with new oil, however.)

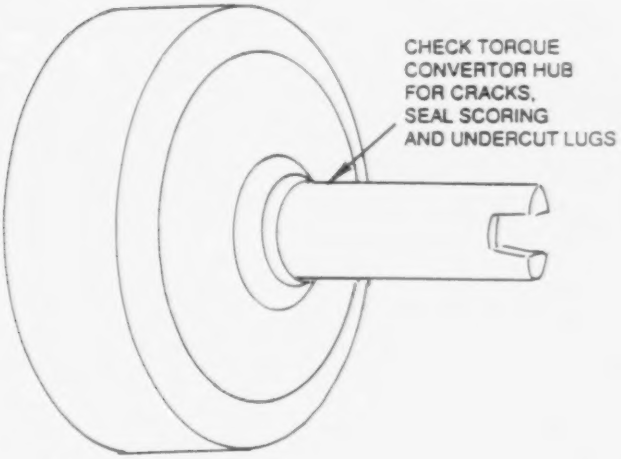
(NOTE: On converters without a drain plug, a 1/8" hole must be drilled into the converter at a location designated by the manufacturer. Old oil drains through this hole. A blind [closed-end] pop rivet is then rivetted in the hole and a small layer of RTV is placed over it.)

2. Torque converters should be inspected for the following: proper flex plate mounting; converter hub condition; proper end play of the stator thrust washer; adequate holding ability of the stator one-way clutch; and excessive stator to turbine interference.

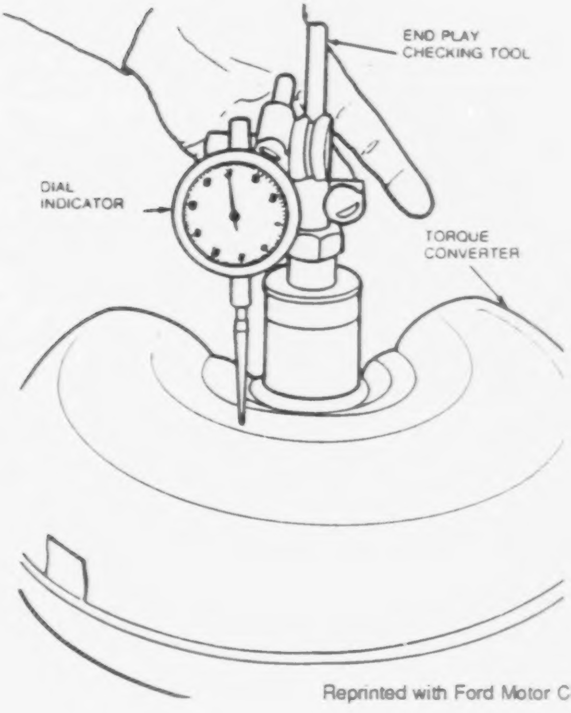
a. Flex plate mounting should be inspected because the converter flex plate is subjected to extreme torque changes. The flex plate can be cracked or bent. After transmission removal, the technician should look for radial cracking around the bolts and cracking from the pilot area to the outside of the flex plate. Cracks in either area can produce a loud banding as the vehicle idles or coasts; however, the noise will stop as the vehicle accelerates or decelerates. The technician should also inspect the pilot area of the crank for rust or dirt. If the converter pilot hub binds in the crankshaft pilot, shaft heat expansion will cause excessive thrust to be applied to the pump gear and the engine thrust bearing.


CHECK FOR CRACKS AT CRANK SHAFT FLANGE AREA
CHECK FOR CRACKS AT TORQUE CONVERTOR AREA

b. Carefully inspect the converter hub for seal scoring, weld cracks, bushing scores, and under-cut drive lugs.


CHECK TORQUE
CONVERTOR HUB
FOR CRACKS,
SEAL SCORING
AND UNDERCUT LUGS

c. A special tool can be used to check end play of the stator thrust washer. The tool uses a dial indicator and a lifting device to move the stator in and out while recording thrust clearance. As a rule, about .050" is the maximum allowable clearance.


END PLAY
CHECKING TOOL
DIAL
INDICATOR
TORQUE
CONVERTER

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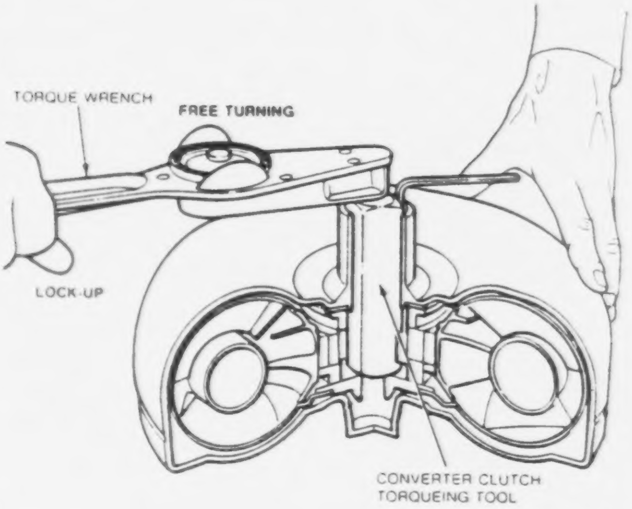
d. The holding ability of the stator one-way clutch can be determined by inserting a dummy stator support shaft into stator and rotating the shaft in both directions with a snap motion. If the stator freewheels in one direction and resists movement in the other, the clutch is not defective. If the stator free wheels in both directions, the clutch is defective. If the stator resists in both directions, the clutch is defective.


TORQUE WRENCH
FREE TURNING
LOCK-UP
CONVERTER CLUTCH TORQUEING TOOL

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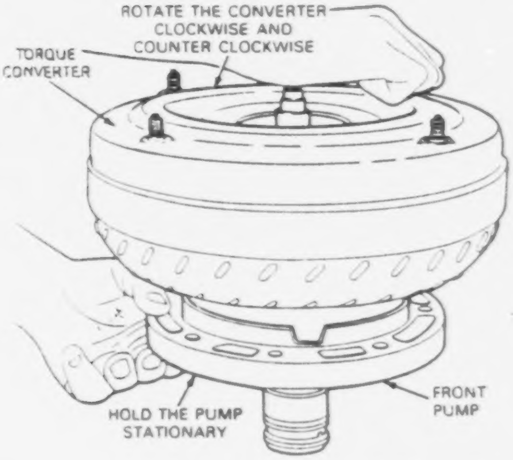
e. To access turbine, stator, and pump interference, the pump body and input shaft can be installed into the converter and rotated. If a scrapping noise or binding is detected, the internal converter parts are touching during the rotation. This condition can leave an aluminum-colored sediment in the fluid pan.


ROTATE THE CONVERTER CLOCKWISE AND COUNTER CLOCKWISE
TORQUE CONVERTER
FRONT PUMP
HOLD THE PUMP STATIONARY

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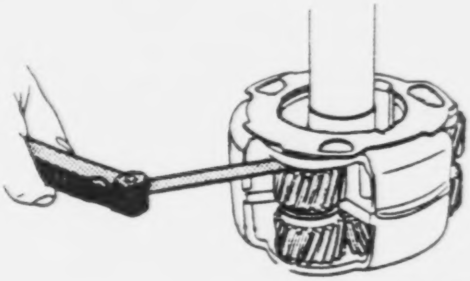
IX. Inspecting and repairing gear train components

A. Procedures for inspecting planetary gear assembly

1. Inspect planetary gear sets for gear length, chipped gear teeth, scored gear teeth, and worn teeth.

2. Inspect planet bearings for tightness by rocking the bearing from side to side.

3. Inspect for planet end play with a feeler gauge. End play typically is .005 through .035 of an inch.



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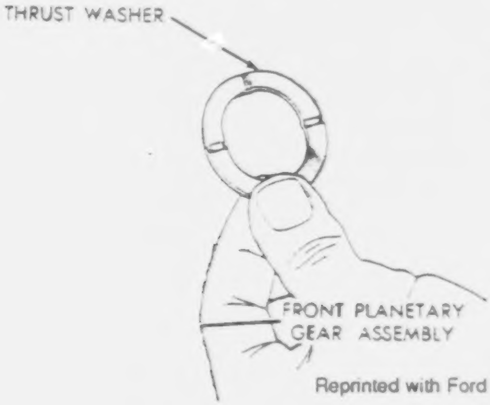
4. Inspect bushing clearance with a feeler gauge. Check for scoring or looseness in bore.

5. Inspect thrust washer for scoring, discoloration from heat, or excessive wear.



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B. Procedure for inspecting gear train shafts, bushing, and sealing rings

1. Inspect shafts for the problems listed below.

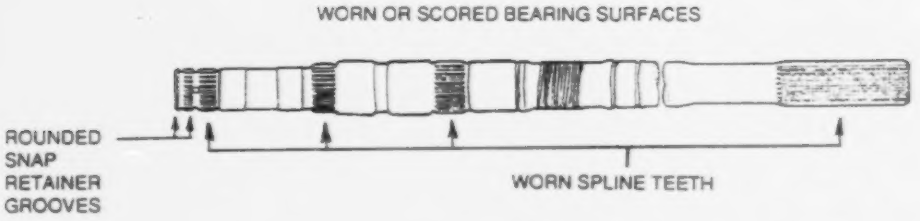
a. Worn bearing surface

b. Scored bearing surface

c. Worn spline teeth

d. Rounded snap retainer grooves

e. Worn internal bushings


WORN OR SCORED BEARING SURFACES
ROUNDED SNAP RETAINER GROOVES
WORN SPLINE TEETH

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2. Inspect shaft sealing rings for the following problems.

   a. Improper side clearance

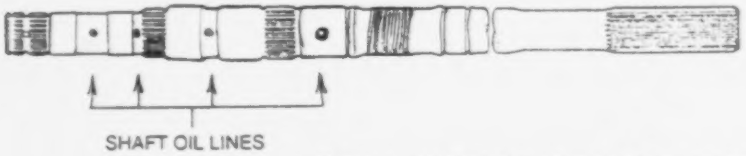
      (NOTE: Typical side clearance is .005 of an inch.)

   b. Worn sealing surface

   c. Cracked separation lands

   d. Improper end clearance

3. Some transmissions have shaft oil delivery circuits, which are internal lubrication passages. These passages should be blown out with a blow gun during overhaul. Doing so will ensure that the passages are not blocked.


SHAFT OIL LINES

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C. The parking pawl engages a slotted hub on the output shaft.

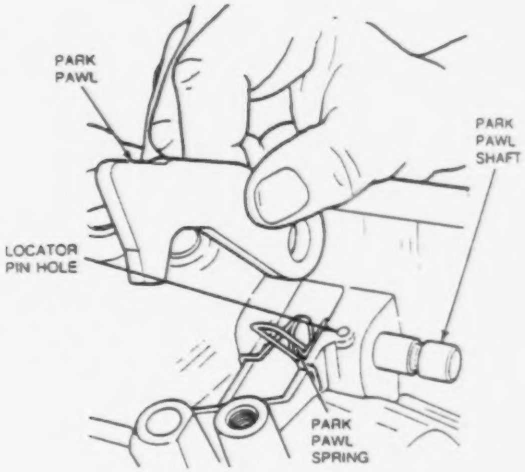
1. The pawl should be inspected for the following problems.

   a. Rounded pawl tooth

   b. Worn pivot shaft

   c. Broken or weak return spring

d. Detent shaft bent or loose


PARK PAWL
PARK PAWL SHAFT
LOCATOR PIN HOLE
PARK PAWL SPRING

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2. The hub should be inspected for the following problems.

   a. Rounded slots

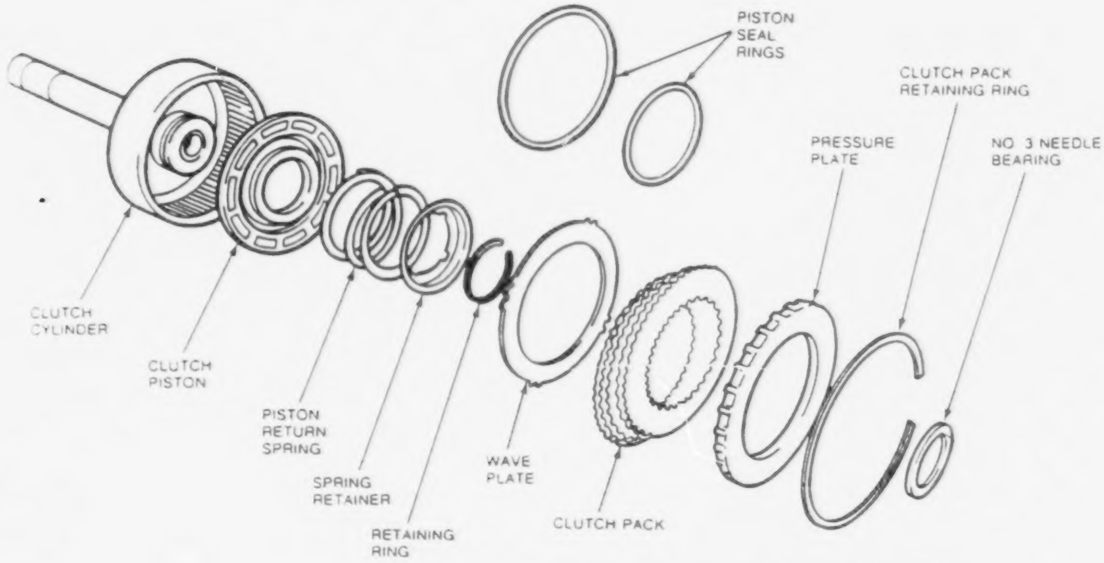
   b. Loose on shaft splines

   c. Broken or missing retainers

X. Inspecting, repairing, and testing friction and reaction units

   A. Procedures for inspecting, repairing, and testing clutch units

1. In order to disassemble a clutch unit, the technician must remove the friction and steel plates and the apply piston and return spring or springs. The clutch elements usually include a pressure plate. A snap ring holds the pressure plate in place. The snap ring may come in a variety of thicknesses, which allow the technician to achieve the correct clutch pack clearance. During application, the hydraulic clutch piston forces the clutch friction elements and the steel plates against the pressure plate. In some clutch packs, a wavy steel plate absorbs the force that results from the application of the clutch plates. The piston will use a return spring system. This return spring system may be a single coil, multiple coils, or a diaphragm or disc spring. A retainer and a snap ring hold the springs.


PISTON SEAL RINGS
CLUTCH PACK RETAINING RING
PRESSURE PLATE
NO. 3 NEEDLE BEARING
CLUTCH CYLINDER
CLUTCH PISTON
PISTON RETURN SPRING
SPRING RETAINER
WAVE PLATE
RETAINING RING
CLUTCH PACK

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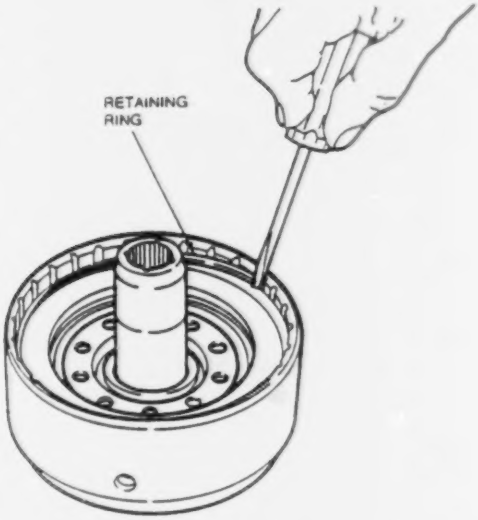
2. Procedures for disassembling clutch units

   a. Flush clutch housing in solvent and blow dry.

      (NOTE: When removing clutch parts, lay them out in the order of disassembly.)

b. Remove the clutch snap ring by prying behind it with a medium screwdriver. Observe the condition of the snap ring surface, especially at the point where the drum slots have been riding. Discard the ring if the slots have cut deep into the ring's surface.



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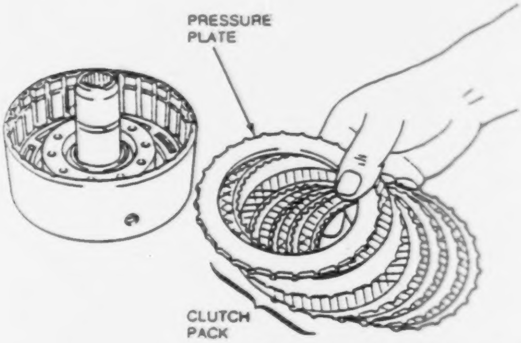
(NOTE: Do not overtwist the ring during removal. Overtwisting may warp the ring.)

(NOTE: The snap ring may be wavy.)

c. Lift out the pressure plate and clutches and set them aside for later inspection. Count and record the number of steel plates and clutch plates removed.



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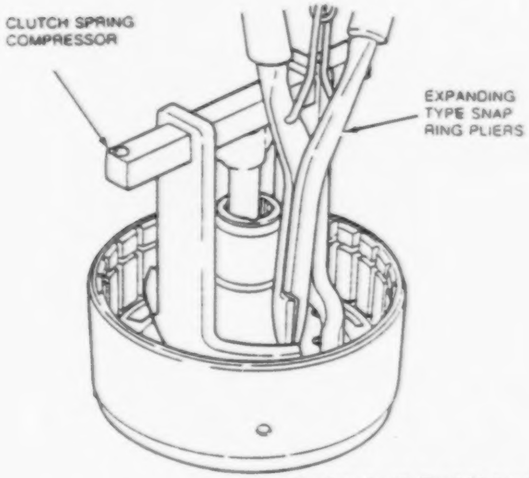
(NOTE: At the bottom of the clutch pack, another pressure plate may be found. If not, the last steel plate may serve as the pressure plate.)

d. Using a special compressor, compress the return spring or springs. When the spring is compressed, the snap ring can be removed. After snap ring removal, the return spring or springs, retainer, and snap ring can be removed.


CLUTCH SPRING COMPRESSOR
EXPANDING TYPE SNAP RING PLIERS

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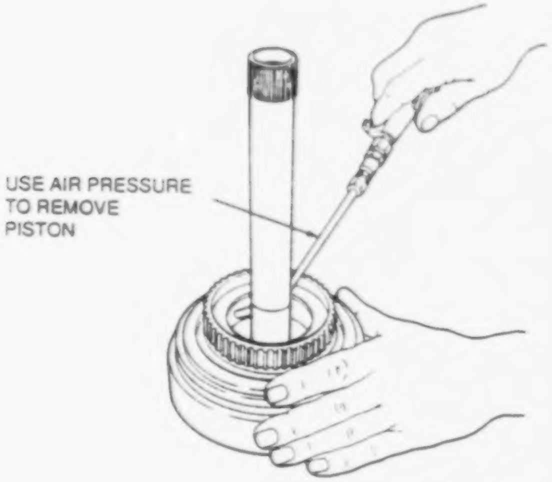
e. Remove the piston by either tapping the clutch housing while the housing is resting upside down on a bench or by blowing air into the oil delivery hole.

(**CAUTION:** If compressed air is used to remove the piston, turn the clutch housing upside down to prevent the pistons and springs from shooting out with great force.)


USE AIR PRESSURE TO REMOVE PISTON

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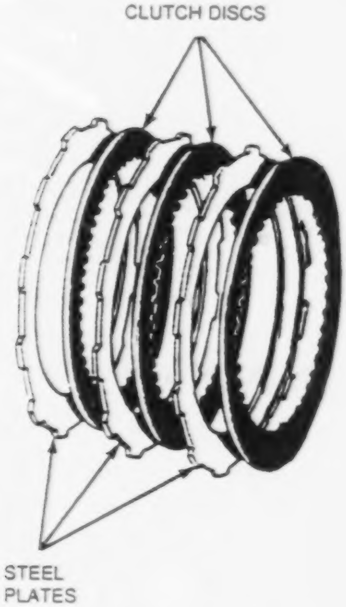
3. Procedure for inspecting clutch components

   a. Inspect the clutch plates for warping or cracks, missing spline teeth, missing clutch material, and excessive wear.

      (NOTE: A set of grooves or slots are cut in the faces of some clutches. The purpose of these slots or grooves is to transport oil from the face during clutch application. However, these slots or grooves can also be used to determine how much the friction material on the clutch face has worn. If the slots or grooves are nearly worn away, very little friction material is left.)

   b. Inspect steel plates for warping, heat discoloration, cracks, scoring and missing lugs.

      (NOTE: When checking steel plates for warping, remember that one steel plate may serve as a cushion spring and, therefore, appear wavy.)



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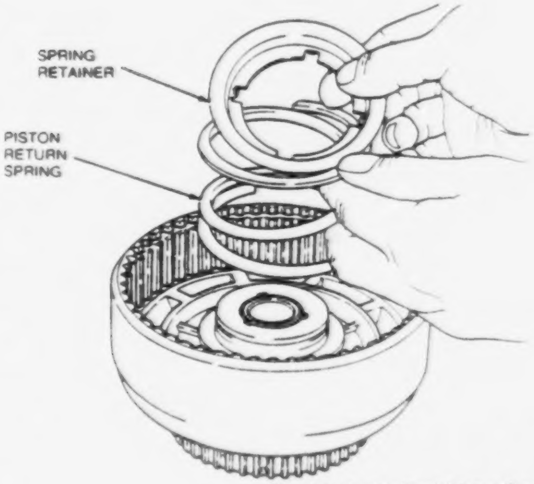
c. Inspect pressure plates for cracks and warps or overheating discoloration.

d. Make sure return springs are not missing or broken. Make sure the diaphragm spring is not flat. The diaphragm spring should be slightly cupped in shape; if it is not, it has lost its tension and must be replaced. Make sure the retainer is not warped. Also make sure that the retainer does not have a distorted snap ring seat.

(NOTE: Some clutches do not use a spring in every opening. Consult the service manual for the correct number of springs for the pressure clutch being serviced.)



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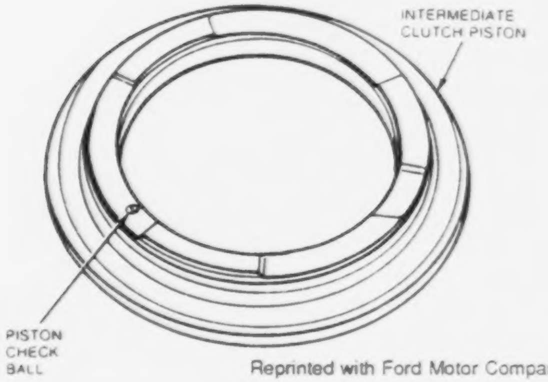
e. Inspect for cracked or broken seal areas on the piston and ball check.

(NOTE: Some pistons have a small ball check located in them. The purpose of the ball check is to vent fluid to the outside of the housing and piston area. The force exerted by the fluid can partially apply the piston when no application is desired, thus causing the clutch plate to lose more friction material. Fluid flow seals the ball check when hydraulic pressure is applied to the piston. This allows clutch engagement at the proper time. Make sure the ball must move freely in its bore.)



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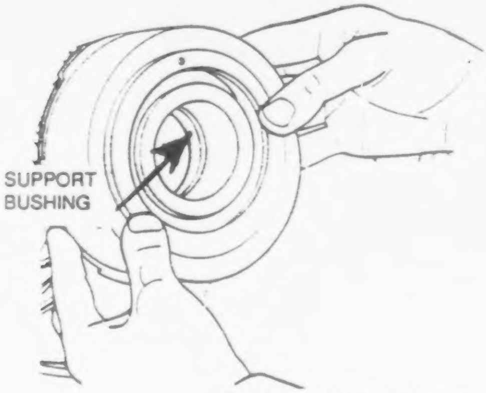
f. Inspect the cylinder area of the housing for scoring or cracks.

g. Inspect the direction of the seals. At this time, the condition of the seals is not important because they will be replaced during overhaul.

4. Inspect the clutch housing components listed below.

   a. The clutch may have a bushing that rides on a hub. Inspect the bushing for wear and replace it as needed. Check the vent ball check, if applicable.



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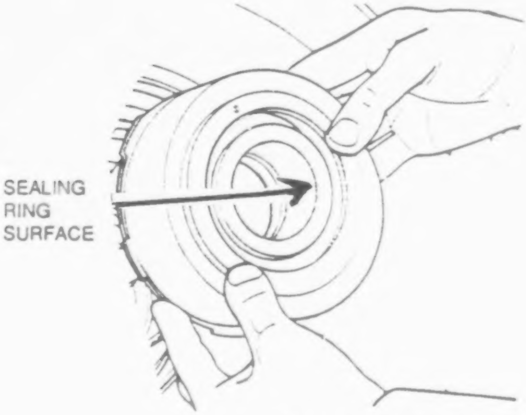
   b. The fluid distribution sealing ring rides on the housing bore. Inspect the bore for signs of ring wear. If the bore has become glazed or polished, deglaze the bore by wrapping a piece of fine emery paper around a foam sponge and rotating it in the bore.



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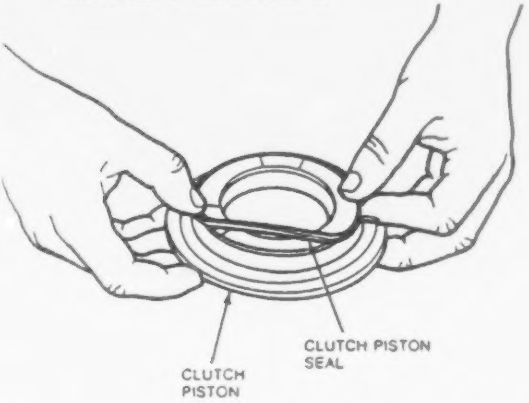
   c. Some clutches are mounted on a drive shaft. Usually the shaft is splined to the housing and retained by snap rings. Check the tightness of the spline fit. Also check the snap rings.

5. When reassembling the clutch, do the tasks listed below.

   a. When installing piston and seals, closely observe the direction of the lip seal. Failure to position the lip seal in the correct direction will cause immediate clutch failure.



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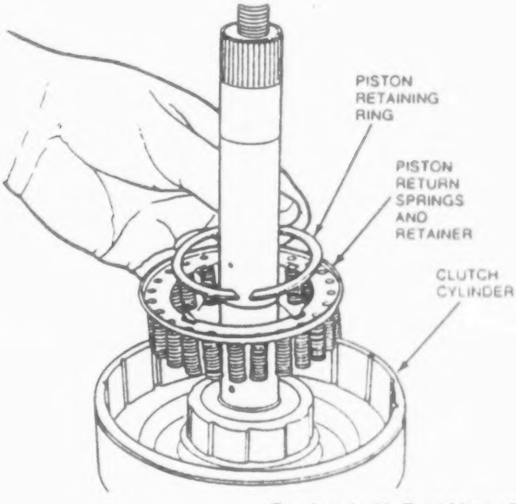
   b. During piston installation, lubricate the seals with petroleum jelly, or automatic transmission fluid. When installing the piston in its bore, use hand pressure only. When fully seated, the piston can be rotated in its bore with hand pressure. If the piston will not rotate, remove and inspect the seal.

   (NOTE: When possible, use a seal tool to assist in curling the lip on the seal into the bore.)

   c. When installing the springs and retainer, be sure to place the spring(s) in the location prescribed by the service manual. Make sure the retainer is not snagged by the snap ring groove as the spring is compressed. Correctly position the snap ring opening, if appropriate.



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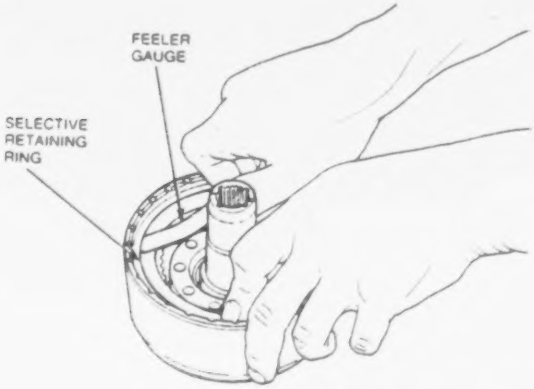
d. Soak the clutch disc in automatic transmission fluid in order to lubricate it. Make sure that the clutch contains the correct number of clutch plates and steel plates. Also make sure the plates are in the correct position.

e. Use a feeler gauge to check clutch plate clearance. If clearance is incorrect, one of the following corrective actions may be appropriate: install thicker selective snap ring; install thicker selective pressure plate; add clutches or steel plates; or install thicker selective steel plate.



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B. Procedure for disassembling and inspecting roller (sprag) clutches

(NOTE: Roller or sprag clutches can be located on clutch housings, pressure plates, or case mountings. Procedures for their inspection and repair are similar regardless of their location. The roller clutch or one-way clutch is considered a reaction holding element because it is not activated with hydraulic controls. The clutch is energized according to its direction.)

1. A retainer and a snap ring hold the roller or sprags in place. Before disassembly, note the spring cage position. The service manual will indicate which way the clutch should lock or freewheel.

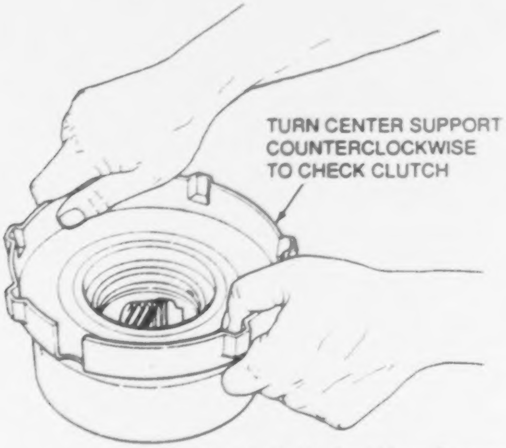
   (NOTE: Be careful not to assemble the one-way clutch incorrectly. If the clutch is assembled incorrectly, the gear train planetaries will not be properly arranged, causing the clutch to lose or lock up gears.)

2. Inspect the rollers or sprags for flaking or pitting.

3. Inspect the clutch races for cracking, flaking, or wear.

4. Inspect return springs.

5. After reassembly is completed, check for proper one-way operation. Also prelubricate the assembly.



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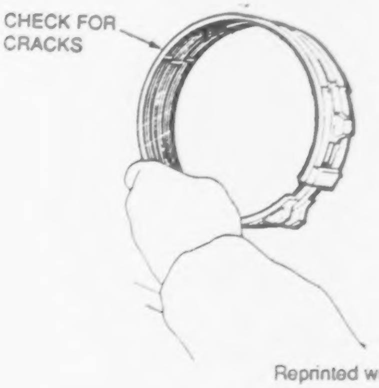
C. Procedure for inspecting bands and drums

1. Inspect the band friction material for flaking separation or excessive wear.

   a. If the band is exposed to excessive heat or fails to receive adequate lubrication, the friction material may lose its bond and begin to flake. If conditions become too severe, the friction material may separate from the apply band.

   b. On most bands, slots in the friction material help to dissipate excessive fluid during application. The band must be replaced when the slots are worn away.

2. Make sure the apply band is not broken or cracked. The band may be made of cast iron or steel. Check the band's circumference for cracks or complete breaks that would prevent its application. Steel bands have a welded anchor point on each end. Make sure welds are tight.



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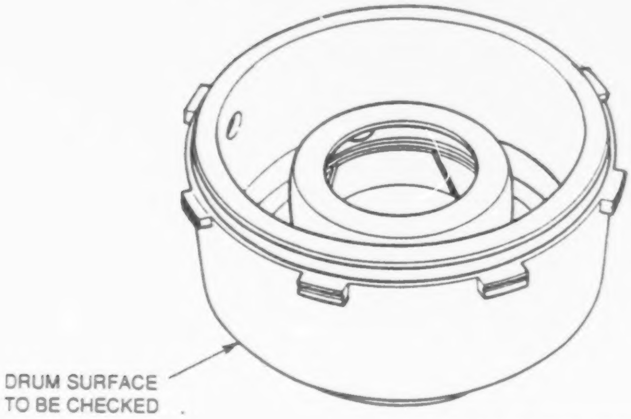
3. Procedure for inspecting drums

   a. Check drum for scoring or overheating.

   b. Check drum for glazing. Deglaze drum if it has become polished.

   c. Check drum for flaking of friction material.



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4. Procedure for inspecting struts

   a. Check struts for bending.

   b. Check struts for broken pivot pins.

   c. Check struts for twisting.

   d. Check struts for worn anchor points.

D. Air testing clutch and servos after assembly

(NOTE: Some clutch and band servos can be air tested after final assembly. Air testing ensures that the clutch and band servos have been assembled correctly and that the hydraulic force will activate properly.)

1. Procedure for air testing clutches (bench test)

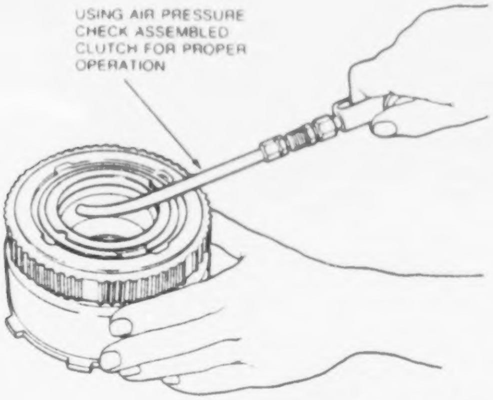
   (NOTE: If the clutch oil supply hole is accessible to an air hose, the clutch can be air tested before it is installed into the transmission.)

   a. During the air test, limit air supply pressure to 50 psi. It is normal to hear a small amount of air leaking past the seals and rings. Squirt automatic transmission fluid into the clutch apply hole.

   b. Mount the clutch on its distribution sleeve, if necessary.

   c. Inject air into the apply port.

d. Observe the clutch pack for tightening. A dull thud may be heard as the piston engages the clutch.


USING AIR PRESSURE
CHECK ASSEMBLED
CLUTCH FOR PROPER
OPERATION

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2. The procedure for air testing a clutch that is installed into the transmission is very similar to the bench test. When the clutch being tested is already installed, however,air pressure is applied through the valve body ports in order to achieve engagement.

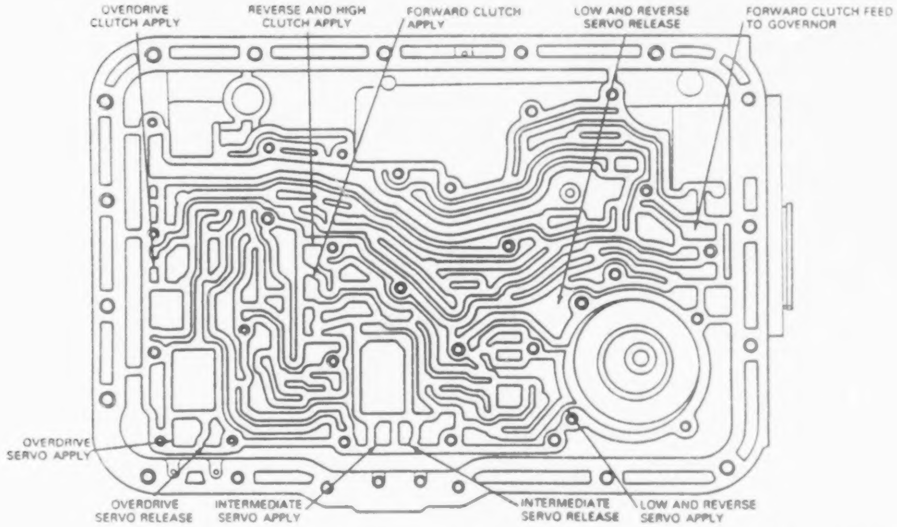
3. Procedure for air testing bands and servos

(NOTE: Bands and servos can be air tested only on assembled transmissions.)

a. Perform a band adjustment according to the manufacturer's procedure.

b. Select the correct port and apply less than 50 psi air pressure.

c. Observe band for tightening. There will be no thud during this test.


OVERDRIVE CLUTCH APPLY
REVERSE AND HIGH CLUTCH APPLY
FORWARD CLUTCH APPLY
LOW AND REVERSE SERVO RELEASE
FORWARD CLUTCH FEED TO GOVERNOR
OVERDRIVE SERVO APPLY
OVERDRIVE SERVO RELEASE
INTERMEDIATE SERVO APPLY
INTERMEDIATE SERVO RELEASE
LOW AND REVERSE SERVO APPLY

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MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

PROCEDURES FOR REMOVING A REAR-WHEEL-DRIVE AUTOMATIC TRANSMISSION

Instructions: **Do the following tasks on a separate sheet of paper.**

(HINT: Use an appropriate service manual.)

1. Record the make, model, and year of the vehicle to be serviced.
2. Develop a written procedure for draining the automatic transmission fluid.
3. Develop a written procedure for removing the drive shaft. Be sure to include all necessary specifications.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

PROCEDURES FOR DISASSEMBLING A REAR-WHEEL-DRIVE AUTOMATIC TRANSMISSION

Instructions: **Do the following tasks on a separate sheet of paper.**

(HINT: Use an appropriate service manual.)

1. Record the make, model, and year of the vehicle to be serviced.
2. Develop a written procedure for disassembling a rear-wheel-drive automatic transmission. Include all necessary specifications.

AS3-L1-UVI

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

PROCEDURES FOR REMOVING A FRONT-WHEEL-DRIVE TRANSAXLE

Instructions: **Do the following tasks on a separate sheet of paper.**

(HINT: Use an appropriate service manual.)

1. Record the make, model, and year of the vehicle to be serviced.
2. Develop a written procedure for removing the transaxle half shafts. Be sure to include all specifications.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

PROCEDURES FOR DISASSEMBLING A FRONT-WHEEL-DRIVE TRANSAXLE

Instructions: Do the following tasks on a separate sheet of paper.

(HINT: Use an appropriate service manual.)

1. Record the make, model, and year of the vehicle to be serviced.
2. Develop a written procedure for mounting the transaxle to the holding fixture and measure input shaft end play. Be sure to include all necessary specifications.
3. Develop a written procedure for disassembling the transaxle. Be sure to include all necessary specifications.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

PROCEDURES FOR DISASSEMBLING AND INSPECTING AN AUTOMATIC TRANSMISSION PUMP

Instructions: **Do the following tasks on a separate sheet of paper.**

(HINT: Use an appropriate service manual.)

1. Record the make, model, and year of the vehicle to be serviced.
2. Develop a written procedure for disassembling an automatic transmission pump. Include all necessary specifications.
3. Develop a written procedure for inspecting an automatic transmission pump. Include all necessary specifications.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

PROCEDURE FOR INSPECTING AND SERVICING THE TORQUE CONVERTER AND FLEX PLATE

Instructions: **Do the following tasks on a separate sheet of paper.**

(HINT: Use an appropriate service manual.)

1. Record the make, model, and year of the vehicle to be serviced.

2. Develop a written procedure for inspecting the torque converter. Make sure to include all necessary specifications.

3. Develop a written procedure for flushing the torque converter. Make sure to include all necessary specifications.

4. Develop a written procedure for inspecting the flex plate. Make sure to include all necessary specifications.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

PROCEDURES FOR INSPECTING THE GEAR TRAIN

Instructions: Do the following tasks on a separate sheet of paper.

(HINT: Use an appropriate service manual.)

1. Record the make, model, and year of the vehicle to be serviced.
2. Develop a written procedure for inspecting the planetary gear sets. Include all necessary specifications.
3. Develop a written procedure for inspecting the gear train shaft. Include all necessary specifications.
4. Develop a written procedure for inspecting the parking pawl system. Include all necessary specifications.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

PROCEDURES FOR INSPECTING, REPAIRING, AND TESTING FRICTION AND REACTION UNITS

Instructions: **Do the following tasks on a separate sheet of paper.**

(HINT: Use an appropriate service manual.)

1. Record the make, model, and year of the vehicle to be serviced.
2. Develop a written procedure for disassembling the clutch unit. Make sure to include all necessary specifications.
3. Develop a written procedure for inspecting the clutch unit. Make sure to include all necessary specifications.
4. Develop a written procedure for reassembling the clutch unit. Make sure to include all necessary specifications.
5. Develop a written procedure for bench testing the clutch unit. Make sure to include all necessary specifications.
6. Develop a written procedure for inspecting or repairing a roller (sprag clutch) one-way clutch.

JS1-L1-UVI

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

REMOVING A REAR-WHEEL-DRIVE AUTOMATIC TRANSMISSION

Equipment:

Hoist or jack and jack stands
Transmission jack
Drain pan
Line plugs
Safety glasses

Procedure:

Evaluation
3 2 1 N

1. Wear safety glasses while doing all procedures on this job sheet. ___ ___ ___ ___
2. Prepare the vehicle for transmission removal by doing the tasks listed below. ___ ___ ___ ___
    a. Disconnect the negative battery cable.
    b. Safely lift and secure the vehicle.
    c. Make sure a proper transmission jack is available.
3. Complete AS1-L1-UVI. Following the procedure developed in item 2 of AS1-L1-UVI, drain the automatic transmission fluid. ___ ___ ___ ___
4. Following the procedure developed in item 3 of AS1-L1-UVI and the steps outlined below, remove the drive shaft from the automatic transmission. ___ ___ ___ ___
    a. Mark the drive shaft for proper installation.
    b. Wrap rear U-joint with tape.
    c. Plug output shaft opening.
5. Following the procedure outlined below, remove transmission linkages, cables, and other related items. ___ ___ ___ ___
    a. Remove speedometer cable/wires.
    b. Remove manual shift linkage/cable.
    c. Remove wiring connections.
    d. Remove cooler lines. Double wrench and plug the lines.

e. Remove throttle/detent valve linkage/cable.

f. Vacuum lines and support clips.

g. Remove any other cables or related items.

6. Following the procedure outlined below, remove components blocking transmission removal. ____

a. Remove bell housing covers.

b. Remove appropriate engine, exhaust, starter and any other engine components blocking transmission removal.

c. Disconnect torque converter from the flywheel.

7. Following the procedure outlined below, remove the transmission from the vehicle. ____

a. Support engine and transmission with a transmission jack.

b. Remove transmission mount and crossmember.

c. Remove bell housing bolts.

d. Move transmission so that it will clear the engine.

e. Lower the transmission from the vehicle and remove.

Average of above evaluations* ____

(This average is a partial evaluation for Competency Ff1. Final evaluation for Ff1 will be made at the end of JS5-L2-UVI.)

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

DISASSEMBLING A REAR-WHEEL-DRIVE AUTOMATIC TRANSMISSION

Equipment:

Transmission holding fixture
Dial indicator
Pry bar or slide hammer
Safety glasses

Procedure:

Evaluation
3 2 1 N

1. Wear safety glasses while doing all procedures on this job sheet. ___ ___ ___ ___

2. Following the procedure outlined below, prepare the transmission for disassembly. ___ ___ ___ ___

    a. Remove the torque converter.

    b. Install the transmission on holding fixture.

    c. Measure and record input shaft end play.

    d. Remove the transmission pan.

    (NOTE: In order to prevent transmission fluid spills, a drain pan should be placed under the transmission during the above steps.)

3. Complete AS2-L1-UVI. Following the procedure developed in item 2 of AS2-L1-UVI, disassemble a rear-wheel-drive transmission. As components are removed, inspect for and record obvious signs of wear such as cracking and scoring. ___ ___ ___ ___

    a. Remove the valve body.

    (NOTE: Watch for ball checks, springs, and linkage.)

    b. Remove extension housing and related components.

    c. Remove pump bolts and pump.

    d. Loosen band adjusters, servos, and struts, if applicable.

    e. Remove input shaft and clutch and drum assemblies.

f. Remove planetary gear sets.

g. Remove output shaft.

h. Record any signs of wear or defects noted during the disassembly.

Average of above evaluations* ____

(This average is a partial evaluation for Competency Ff1. Final evaluation for Ff1 will be made at the end of JS5-L2-UVI.)

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

CLEANING AND INSPECTING A REAR-WHEEL-DRIVE TRANSMISSION

Equipment:

Steam cleaner, jet cleaner, or solvent tank
Straightedge
Feeler gauge
Safety glasses

Evaluation
3 2 1 N

Procedure:

1. Wear safety glasses while doing all procedures on this job sheet. ___ ___ ___ ___

2. Following the procedure outlined below, clean and inspect a rear-wheel-drive transmission. ___ ___ ___ ___

    a. Rinse internal components with clean solvent and set them aside.

    b. Clean the transmission case with a steam cleaner, jet spray, or solvent.

    (NOTE: If the final drive has not been disassembled, flush the case with solvent only.)

    c. Visually inspect the case for cracks.

    d. Visually inspect the bushings for wear or bore failure.

    e. Using the straightedge and feeler gauge, check the flatness of the valve body mating surfaces.

    f. Record the results of the inspection.

Average of above evaluations* ___ ___ ___ ___

(This average is a partial evaluation for Competency Ff1. Final evaluation for Ff1 will be made at the end of JS5-L2-UVI.)

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

REMOVING A FRONT-WHEEL-DRIVE TRANSAXLE

Equipment:

Hoist or jack and jack stands
Transaxle jack
Engine support fixture
Shaft holding fixtures
Drain pan
Line plugs
Safety glasses

Procedure:

Evaluation
3 2 1 N

1. Wear safety glasses while doing all procedures on this job sheet. __ __ __ __

2. Following the procedures outlined below, prepare the transaxle for removal. __ __ __ __

    a. Disconnect the negative cable of the battery.

    b. Drain the fluid from the transaxle.

    c. Remove and plug transaxle cooler lines.

    d. Disconnect the speedometer cable or sensor unit.

    e. Disconnect any related wirings.

    f. Disconnect transaxle linkages (detent or manual valve).

    g. Disconnect any vacuum lines or clips.

3. Complete AS3-L1-UVI. Following the procedure developed in item 2 of AS3-L1-UVI, remove the half shafts from the transaxle. __ __ __ __

4. Following the procedure outlined below, remove components blocking transaxle removal. — — — —

   (NOTE: Refer to the proper service manual for specific procedures for removing the half shafts.)

   a. Remove transaxle dust cover.

   b. Remove the flywheel to the torque converter bolts.

      (NOTE: Mark the position of the torque converter on the flywheel for reassembly.)

   c. Remove the starter, if necessary.

   d. Remove the exhaust.

5. Following the procedure outlined below, remove the transaxle from the vehicle. — — — —

   a. Install engine support fixture.

   b. Install the transmission jack and place safety chain around transaxle.

   c. Remove the transaxle mount.

   d. Remove the transaxle-to-engine bolts and move the transaxle away from the engine slightly.

   e. Lower the transaxle from the vehicle.

   Average of above evaluations* — — — —

   (*This average is a partial evaluation for Competency Ff1. Final evaluation for Ff1 will be made at the end of JS5-L2-UVI.)

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

DISASSEMBLING A FRONT-WHEEL-DRIVE TRANSAXLE

Equipment:

Transaxle holding fixture
Dial indicator
Pry bar or slide hammer
Safety glasses

Evaluation
3 2 1 N

Procedure:

1. Wear safety glasses while doing all procedures on this job sheet. __ __ __ __

2. Complete AS4-L1-UVI. Following the procedure developed in item 2 of AS4-L1-UVI, mount the front-wheel-drive transaxle to the holding fixture and measure input shaft end play. __ __ __ __

3. Following the procedure developed in item 3 of AS4-L1-UVI and the steps listed below, disassemble a front-wheel-drive automatic transaxle. __ __ __ __

    a. Remove fluid pan.

    b. Remove valve body.

    c. Remove governor.

    d. Remove pump.

    e. Remove input shaft, clutches, and drums.

    f. Remove band assemblies.

    g. Remove planetary sets.

    h. Inspect thrust washers.

    i. Remove rear transfer cover.

    j. Perform clearance or chain tension check, if appropriate.

k. Measure end play of the output transfer shaft. Record measurement.

l. Remove retaining nuts/sprockets or gears.

m. Disassemble final drive.

Average of above evaluations* — — — —

(*This average is a partial evaluation for Competency Ff1. Final evaluation for Ff1 will be made at the end of JS5-L2-UVI.)

JS6-L1-UVI

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

CLEANING AND INSPECTING A FRONT-WHEEL-DRIVE TRANSAXLE

Equipment:

Steam cleaner, jet cleaner, or solvent tank
Straightedge
Feeler gauge
Safety glasses

Evaluation
3 2 1 N

Procedure:

1. Wear safety glasses while doing all procedures on this job sheet. __ __ __ __

2. Following the below procedure, clean and inspect a front-wheel-drive transaxle. __ __ __ __

   a. Rinse internal components with clean solvent and set them aside.

   b. Clean the transaxle case with a steam cleaner, jet spray, or solvent.

      (NOTE: If the final drive has not been disassembled, flush the case with solvent only.)

   c. Visually inspect the case for cracks. Record observations below.

   d. Visually inspect the bushings for wear or bore failure. Record observations below.

   e. Using the straightedge and feeler gauge, check the flatness of the valve body mating surfaces. Record observations below.

Average of above evaluations* __ __ __ __

(This average is a partial evaluation for Competency Ff1. Final evaluation for Ff1 will be made at the end of JS5-L2-UVI.)

JS7-L1-UVI

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

DISASSEMBLING AND INSPECTING AN AUTOMATIC TRANSMISSION PUMP

Equipment:

Feeler gauge
Straightedge
Safety glasses

Procedure: Evaluation 3 2 1 N

1. Wear safety glasses while doing all procedures on this job sheet. __ __ __ __

2. Complete AS5-L1-UVI. Following the procedure developed in item 2 AS5-L1-UVI and the steps listed below, disassemble the transmission pump. __ __ __ __

    a. Remove pump housing through bolts.

    b. Separate the pump cover from the housing.

    c. Remove the gear, rotor, or vanes.

    d. Remove pressure regulating valve, if applicable.

    e. Remove drain back or high pressure relief valve, is applicable.

3. Following the procedure developed in item 3 of AS5-L1-UVI and the steps listed below, inspect the transmission pump. __ __ __ __

    a. Inspect pump housing gear pocket for scoring, galling, cracking, or wear.

    b. Measure rotor to case clearance with a feeler gauge. Compare measurement to specifications.

    c. Measure rotor to pump face clearance with a straightedge and feeler gauge. Compare measurement to specifications.

    d. Inspect pump turbine shaft bushings for wear. Replace as needed.

    e. Inspect pressure regulating valve, drain back, or high pressure relief valves for wear and seizing (valve body method).

f. Inspect distribution sealing rings for polishing, breaks, or rounding of the edges.

g. Inspect pump outer seals and torque converter seals.

h. Record the results of the inspection.

Average of above evaluations* ____

(*This average is a partial evaluation for Competency Ff2. Final evaluation for Ff2 will be made at the end of JS8-L1-UVI.)

JS8-L1-UVI

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

INSPECTING AND SERVICING THE TORQUE CONVERTER AND FLEX PLATE

Equipment:

Hoist, or jack and jack stands
Torque converter flusher
Drain pan
Electric drill and bits(optional)
End play checking tool
Dummy starter shaft
Safety glasses

Procedure:

Evaluation
3 2 1 N

1. Wear safety glasses while doing all procedures on this job sheet. ___ ___ ___ ___

2. Complete AS6-L1-UVI. Following the procedures developed in item 2 of AS6-L1-UVI and the steps listed below, inspect the torque converter. ___ ___ ___ ___

   a. Visually inspect the torque converter hub for the following: seal scoring; weld cracks, bushing scoring. Also inspect the undercut drive lugs.

   b. Install the end play checking tool and check the end play of the starter thrust washer. Record the reading.

   c. Install a dummy starter support shaft and check the starter clutch for free wheeling and lockup operation. Also check the clutch for turbine to starter rotational interference.

      (NOTE: If any defective conditions are found, the torque converter will need to be replaced.)

   d. Record the results of the inspection.

3. Using the procedures outlined in item 3 of AS6-L1-UVI, flush the torque converter. — — — —

(NOTE: Make sure to check the converter to make sure it has no other defects. Make sure the converter is attached to the flusher according to manufacturer's recommendations.)

4. Using the procedure outlined in item 4 of AS6-L1-UVI, inspect the flex plate. Record the results of the inspection. — — — —

Average of above evaluations* — — — —

(*This average is a partial evaluation for Competency Ff2. Final evaluation for Ff2 will be made below.)

FINAL EVALUATION INSTRUCTIONS

I. Determine the student's final evaluation for Ff2 by averaging the evaluations of JS7-L1-UVI and JS8-L1-UVI. Use the spaces provided below.

Evaluation
3 2 1 N

JS7-L1-UVI — — — —

JS8-L1-UVI — — — —

Final evaluation for Competency Ff2 — — — —

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

INSPECTING THE GEAR TRAIN

Equipment:

Feeler gauge
Blow gun and air hose
Safety glasses

Evaluation
3 2 1 N

Procedure:

1. Wear safety glasses while doing all procedures on this job sheet. ___ ___ ___ ___

2. Complete AS7-L1-UVI. Following the procedure developed in item 2 of AS7-L1-UVI and the steps listed below, inspect the planetary gear sets. ___ ___ ___ ___

   a. Inspect planetary sun gear, planet pinions, and internal gear teeth for chipping, scoring, and wear.

   b. Inspect planet pinion bearing for rocking looseness.

   c. Using a feeler gauge, measure planet pinion bearing end play. Compare measurement with specification to determine if end play is excessive.

   d. Inspect carrier, sun gear, or internal gear bushings for wear and looseness.

   e. Inspect thrust bearing for scoring heat discoloration or wear.

   f. Record the results of the inspection.

3. Following the procedure developed in item 3 of AS7-L1-UVI and the steps listed below, inspect the gear train shaft. ___ ___ ___ ___

   a. Inspect shafts for the following problems: worn bearing surface; scored bearing surface; worn spline teeth; rounded snap ring grooves; worn internal bushings.

   b. Using a feeler gauge, measure side clearance of the shaft sealing rings. Compare measurement to specification to determine if side clearance is acceptable.

   c. Check shaft sealing rings for worn sealing surfaces for cracked separation lands on oil distribution sleeves.

d. Using a feeler gauge, measure end clearance of the shaft sealing rings. Compare measurement to specification to determine if end clearance is acceptable.

e. Record the results of the inspection.

4. Following the procedure outlined in item 4 of AS7-L1-UVI and the steps listed below, inspect the parking pawl system. ____

   a. Inspect the parking pawl for the following problems: rounded pawl tooth; worn pivot shaft; broken return spring; and broken, bent, or loose detent shaft.

   b. Inspect parking pawl hub for the following problems: rounded, broken slots; looseness on shaft spines; and broken or missing retainer snap ring.

   c. Record the results of the inspection.

Average of above evaluations* ____

(*This average is the final evaluation for Competency Ff3.)

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

INSPECTING, REPAIRING, AND TESTING FRICTION AND REACTION UNITS

Equipment:

Spring compressor
Snap ring pliers
Screwdriver
Emery paper
Ice pick
Seal installation tool or feeler gauge
Petroleum jelly and automatic transmission fluid
Air hose, regulator, and blow gun
Safety glasses

Procedure:

Evaluation
3 2 1 N

1. Wear safety glasses while doing all procedures on this job sheet. ___ ___ ___ ___

2. Complete AS8-L1-UVI. Following the procedures developed in item 2 of AS8-L1-UVI and the steps outlined below, disassemble the clutch unit. ___ ___ ___ ___

    a. Flush clutch housing in solvent and blow dry.

    b. Remove clutch pack retainer ring with a screwdriver.

    c. Remove the pressure plate.

    d. Remove clutch disc and steel plates.

    e. Compress return spring with compressor, if applicable.

    f. Remove spring retainer snap ring.

    g. Remove compressor.

    h. Remove lower pressure plate.

    i. Remove piston with air or tap the clutch housing on the bench.

3. Following the procedures developed in item 3 of AS8-L1-UVI and the steps outlined below, inspect the clutch unit. ___ ___ ___ ___

    a. Inspect clutch plates for the following problems: warping or cracking; missing spline teeth; missing or flaking clutch material; and loss of drain slots.

b. Inspect steel plates for the following problems: warping; heat discoloration; cracking; and scoring and missing lugs.

c. Inspect pressure plates for cracks, warps or overheating distortion.

d. Inspect return springs for the following problems: broken springs, missing springs; and flattened diaphragm spring, if applicable.

e. Inspect piston and seals for breaks or cracks.

f. Inspect ball check operation with an ice pick, if applicable.

g. Inspect cylinder area for scoring or cracking, if applicable.

h. Inspect seal direction.

i. Inspect the clutch housing.

j. Inspect clutch housing support bushings for wear; replace as needed.

k. Inspect clutch housing vent ball check operation with an ice pick.

l. Inspect clutch housing sealing ring surface; deglaze if necessary.

m. Inspect shaft to housing spline.

n. Inspect retainer snap rings.

o. Inspect snap ring groove.

p. Record the results of the inspection.

4. Following the procedures developed in item 4 of AS8-L1-UVI and the steps outlined below, reassemble the clutch unit.

a. Make sure seal is installed in the correct direction.

(NOTE: A slip seal installed wrong will cause immediate failure of the clutch assembly.)

b. Prelubricate clutches and seals.

c. Install piston with light hand pressure and install tool.

d. Check piston installation by rotating.

e. Arrange springs and retainer according to service manual.

f. Compress spring and install snap ring.

g. Install pressure plates, clutch, and steel disc according to service manual.

h. Install snap ring.

i. Record clutch clearance and compare it to specification. If clearance is not within specification, consult the instructor for corrective measures.

5. Following the procedures developed in item 5 of AS8-L1-UVI and the steps outlined below, bench test the clutch unit. — — — —

a. Limit air supply to 50 psi.

b. Put automatic transmission fluid into the appropriate supply hole.

c. Inject air into supply hole.

d. Listen for a thud and observe the clutches as they apply.

e. Record the results of the bench test.

6. Following the procedure outlined below, inspect band and friction surfaces. — — — —

a. Inspect band friction surfaces for flaking separation and excessive wear.

b. Inspect apply band for cracks, broken welds, and misaligned anchor lugs.

c. Inspect drums for scoring or heat discoloration, glazing (deglaze with emery cloth as required), flaking or checking of the surface.

d. Inspect struts for bending, twisting, excessive wear, or breakage.

e. Record the results of the inspection.

7. Following the procedure developed in item 6 of AS8-L1-UVI and the steps outlined below, inspect and/or repair a roller (sprag clutch) one-way clutch. ____

   a. Remove roller retainer snap ring and retainer.

   b. Remove rollers (sprags) and springs.

   c. Inspect rollers for flaking or pitting. Record observations.

   d. Inspect return springs for broken or collapsed springs. Record observations.

   e. Upon completion of reassembly, check for proper one-way operation.

   f. Prelubricate with automatic transmission fluid.

   Average of above evaluations* ____

   (*This average is a partial evaluation for Competency Ff4. Final evaluation for Ff4 will be made at the end of JS3-L2-UVI.)

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

UNIT VI: OFF-CAR TRANSMISSION/TRANSAXLE REPAIR

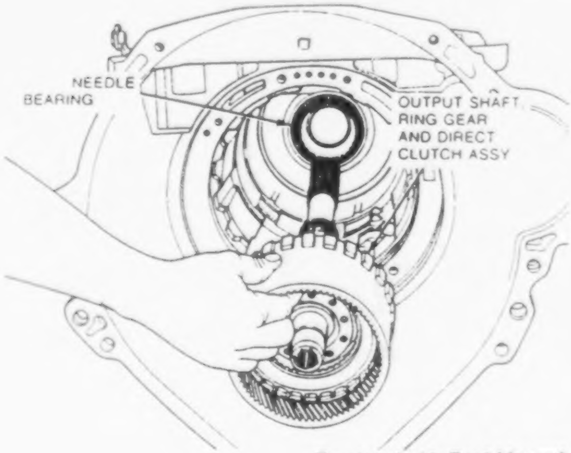
LESSON 2: REASSEMBLY AND REINSTALLATION OF THE TRANSMISSION/TRANSAXLE

I. Procedures for reassembling transmission units

(NOTE: Before reassembly can begin, the transmission sub-assemblies must be disassembled, inspected, and repaired. To maintain continuity of the reassembly procedure outlined below, the inspection and repair procedures will be covered later.)

A. Rebuild and or repair all unit subassemblies.

B. Install output shaft. The output shaft may include sealing rings. These rings must be carefully compressed as the shaft is installed. Other rings require a special holding fixture to position the shaft in the correct alignment.



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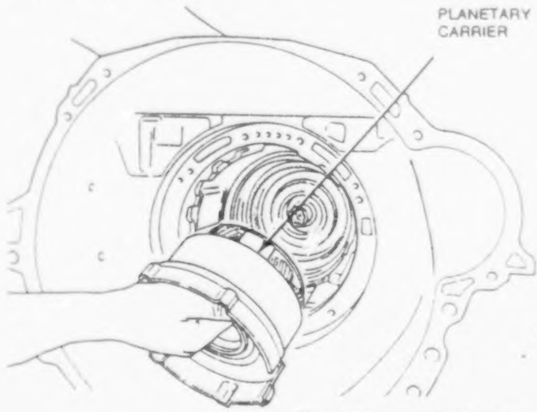
C. Install gear set and clutch units. During clutch unit installation, the clutch splines must allow the full seating of the unit. When the unit appears to be completely in (or down), lift the unit slightly and allow it to drop on its thrust washer. A solid "thunk" should be heard as the unit drops on the washer. If the unit is springy or if it makes a crackling sound as it is dropped, the clutch is not completely indexed.



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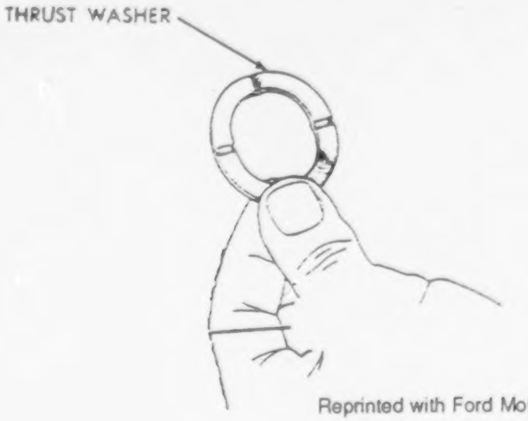
(NOTE: The unit thrust washers should be inspected when they are installed. Make sure that the washers are facing in the right direction and that any tangs are engaging the location holes or lugs. In order to stick the washers in position temporarily, use petroleum jelly. Inspect washer surfaces for excessive wear. If fluid bleed grooves are almost gone or if excessive scoring is found on the thrust face, wear is excessive. Choose the correct selective thrust washer to obtain the proper end play clearance.)



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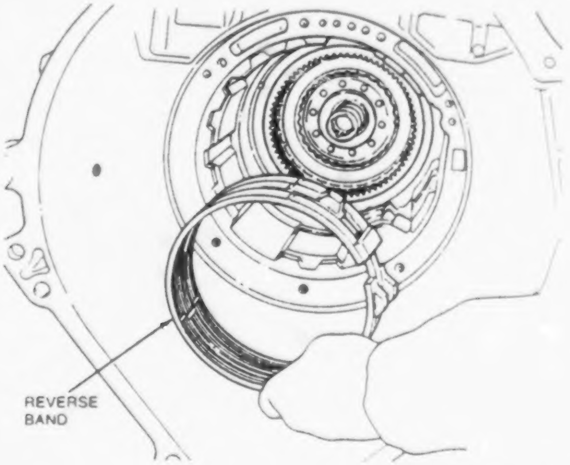
D. Install band assemblies and servos. Make sure the band anchors and apply pins or struts are engaged correctly. Some manufacturers specify that all clutch and band units be prelubricated before installation. Some also specify that the band adjustment screw be tightened in order to keep the drum assembly in place for further assembly.



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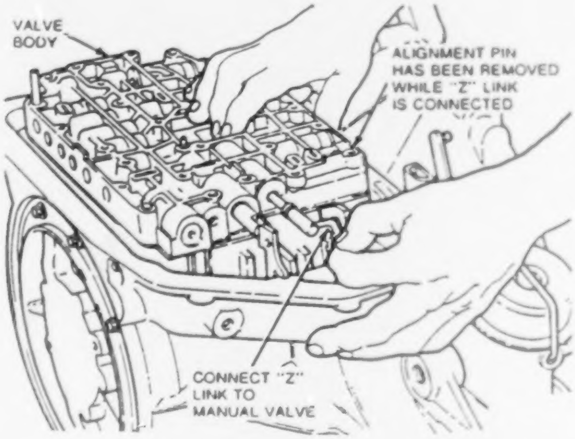
E. Install pump and gasket. Torque the pump to specification. In order to hold the thrust washer and pump gasket in place during installation, use petroleum jelly. Never use gasket sealer.

F. Install extension housing and related components.

G. Install valve body.

(NOTE: During valve body installation, many related components must also be connected, aligned, or installed. Follow the service manual procedure closely.)


VALVE BODY
ALIGNMENT PIN HAS BEEN REMOVED WHILE "Z" LINK IS CONNECTED
CONNECT "Z" LINK TO MANUAL VALVE

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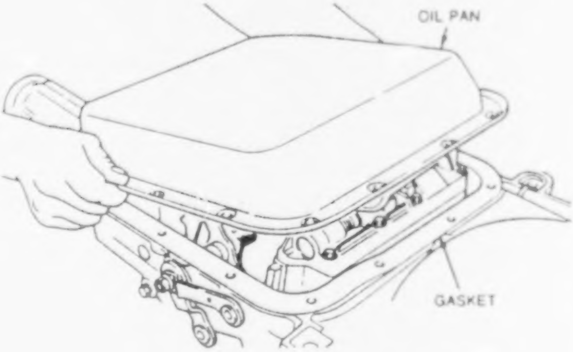
H. Install fluid pan. Use petroleum jelly to keep the gasket in place. Some late model transmissions use a special RTV sealer instead of a gasket. Use only enough sealer to meet the manufacturer's recommendation.


OIL PAN
GASKET

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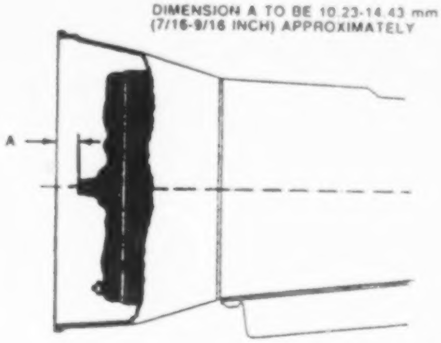
I. Install torque converter. During converter installation, splines or lugs for the following components must be engaged: the stator shaft (reaction shaft) splines; the turbine shaft splines; and the pump drive lugs. To ensure that the converter is completely engaged, measure the depth of the converter to the bell housing. Compare this measurement to the distance of the flex plate from the engine block. Use a wire or metal bar to hold the converter in position temporarily.


DIMENSION A TO BE 10.23-14.43 mm
(7/16-9/16 INCH) APPROXIMATELY
A

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II. Procedures for reinstalling the transmission

A. Mount transmission on a suitable jack.

B. Lift transmission into place.

C. Align location guides with the transmission dowel. Guides are usually used to guide the transmission engagement to the engine. If no guides are present, cut off the head of two long bolts and thread them into the bolt holes on either side of the transmission. These bolts will serve as guides. After transmission installation, remove the guide bolts and replace them with the proper bolt. Also remove the temporary converter holding device for the converter after transmission installation.

D. Install transmission. Thread all housing bolts in several turns. (Do not tighten the bolts until all the bolts are in place.) Tighten housing bolts to specifications.

E. Align and install torque converter to flex plate bolts. Index to punch marks.

F. Install crossmember and mount.

G. Connect transmission related components. Connect negative battery terminal.

H. Install drive shaft.

I. Add proper transmission fluid, if necessary.

(NOTE: Fluid will have to be added if the torque converter is empty.)

J. Test transmission operation.

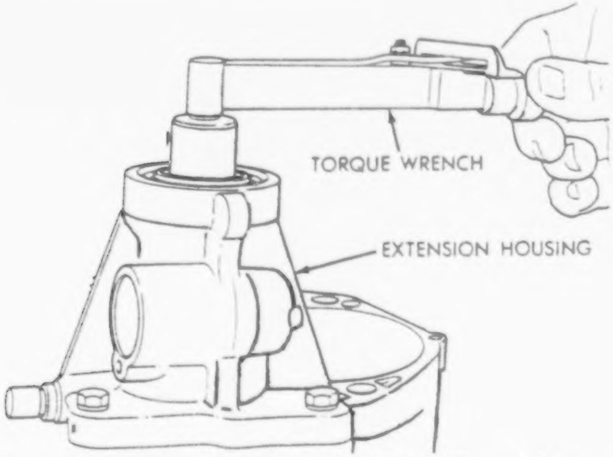
III. Procedures for assembling an automatic transaxle

A. Install final drive assembly according to the procedure outlined below.

(NOTE: RTV may be used as bearing retainer sealer.)

1. Using the end play reading recorded earlier, select a shim that will achieve correct differential bearing preload.

2. Measure bearing preload with a torque wrench.


TORQUE WRENCH
EXTENSION HOUSING

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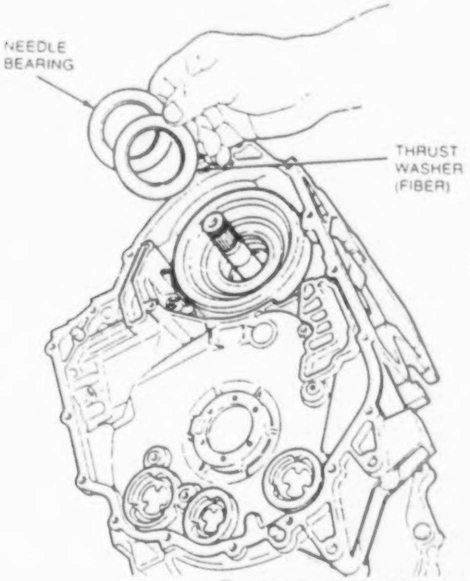
3. Select appropriate shim for output (transfer) shaft.


NEEDLE BEARING
THRUST WASHER (FIBER)

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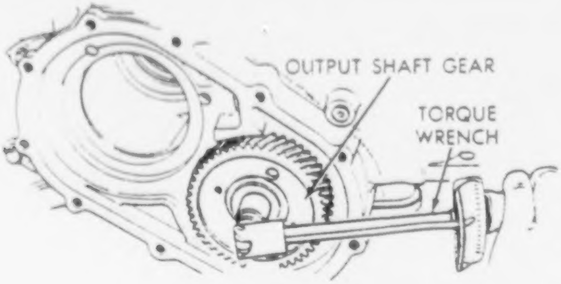
B. Measure output shaft preload with a torque wrench.


OUTPUT SHAFT GEAR
TORQUE WRENCH

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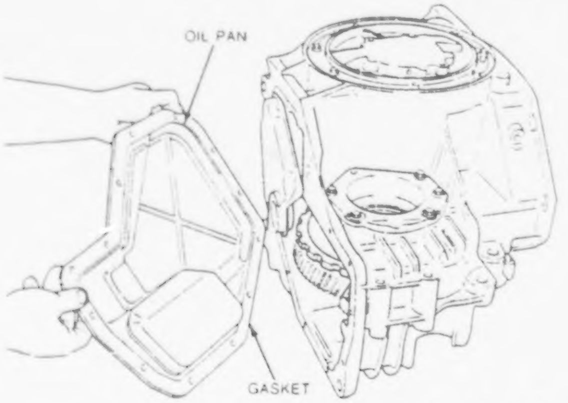
C. Tighten all retainer bolts to specified torque.

D. Install rear and differential covers.


OIL PAN
GASKET

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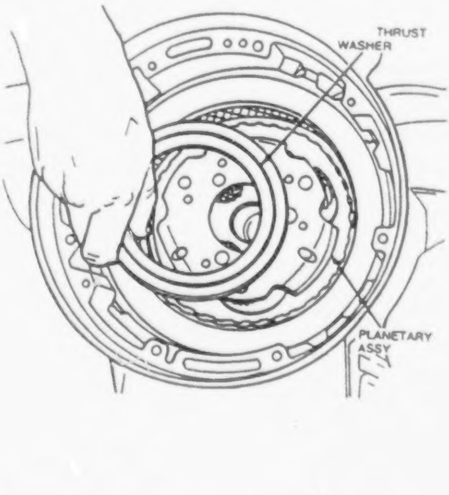
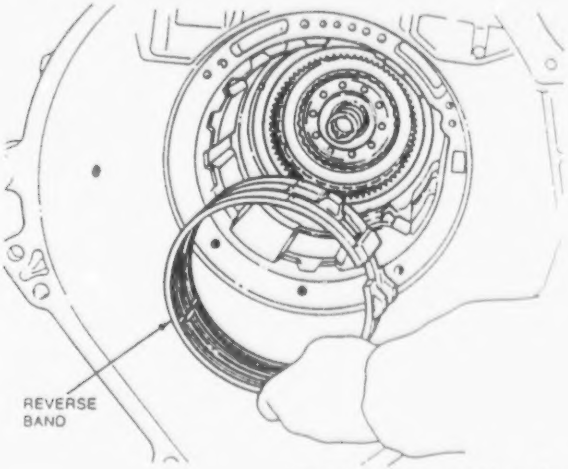
E. Install planetary gear sets. Inspect thrust washers (same as transmissions).

F. Select and install correct thrust washers.


THRUST WASHER
PLANETARY ASSY

G. Install bands, servos, struts, and adjusting screws.



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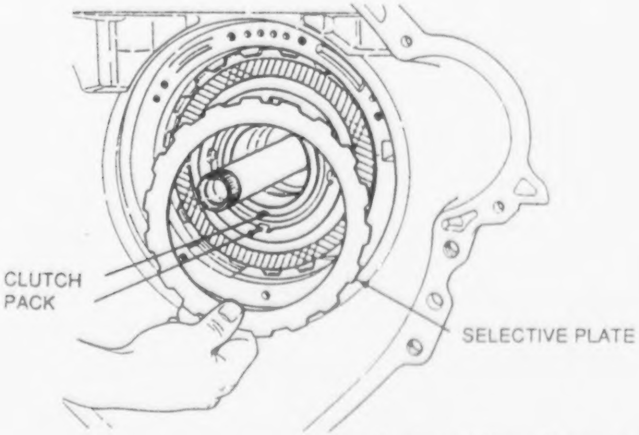
H. Install clutches, drums, and input shaft.



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I. Install pump.

J. Install valve body, governor, and fluid pan.

IV. Following the procedure outlined below, install the transaxle.

A. Place the transaxle on a suitable jack.

B. Lift the vehicle.

C. Install the torque converter.

D. Measure converter depth.

E. Lift the transaxle into the vehicle.

(NOTE: If the half shafts have remained in the vehicle, inspect the CV joints and boots for ruptures or wear. Defective half shafts should be repaired before proceeding.)

F. Align transaxle to dowel pin guides and install.

G. Install bell housing bolts.

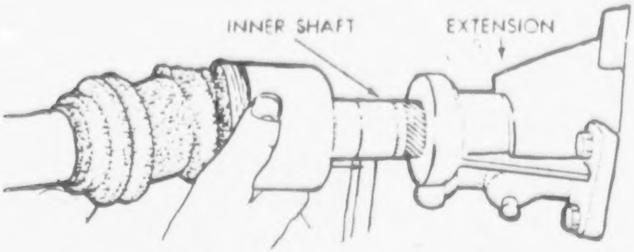
H. Install mounts.

(NOTE: Some manufacturers require that the transaxle be centered. If centering is required, do not completely tighten the mounts.)

I. Remove the jack.

J. Install the half shafts.

(NOTE: Half shafts are held in by a variety of means. Refer to the module Manual Transmission/Transaxle or a service manual for further instruction.)



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K. Install engine related components.

L. Install front wheels/torque.

M. Lower vehicle.

N. Perform mount centering procedure, if applicable.

O. Fill with approved automatic transmission fluid according to manufacture's procedures.

P. Test transaxle operations.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

PROCEDURES FOR REASSEMBLING A REAR-WHEEL-DRIVE AUTOMATIC TRANSMISSION

Instructions: **Do the following tasks on a separate sheet of paper.**

(HINT: Use an appropriate service manual.)

1. Record the make, model, and the year of the vehicle to be serviced.
2. Develop a written procedure for reassembling a rear-wheel-drive automatic transmission.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

PROCEDURES FOR REASSEMBLING A TRANSAXLE

Instructions: **Do the following tasks on a separate sheet of paper.**

(HINT: Use an appropriate service manual.)

1. Record the make, model, and year of the vehicle to be serviced.
2. Develop a written procedure for reassembling the final drive of a front-wheel-drive automatic transaxle. Include all necessary specifications.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

PROCEDURES FOR AIR TESTING THE OPERATION OF CLUTCH PACKS AND SERVO ASSEMBLIES

Instructions: Do the following tasks on a separate sheet of paper.

(HINT: Use an appropriate service manual.)

1. Record the make, model, and year of the vehicle to be serviced.
2. Develop a written procedure for air testing the operation of the clutch assembly. Include all necessary specifications.
3. Develop a written procedure for air testing the operation of the servo assembly. Include all necessary specifications.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

PROCEDURES FOR REINSTALLING A REAR-WHEEL-DRIVE AUTOMATIC TRANSMISSION

Instructions: **Do the following tasks on a separate sheet of paper.**

(HINT: Use an appropriate service manual.)

1. Record the make, model, and year of the vehicle to be serviced.
2. Develop a written procedure for installing the drive shaft. Be sure to include all necessary specifications.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

PROCEDURES FOR REINSTALLING A TRANSAXLE

Instructions: **Do the following tasks on a separate sheet of paper.**

(HINT: Use an appropriate service manual.)

1. Record the make, model, and year of the vehicle to be serviced.
2. Develop a written procedure for reinstalling a transaxle.

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

REASSEMBLING A REAR-WHEEL-DRIVE AUTOMATIC TRANSMISSION

Equipment:

Assembly fluid
Petroleum jelly
Dial indicator
Torque wrench
Safety glasses

Evaluation
3 2 1 N

Procedure:

1. Wear safety glasses while doing all procedures on this job sheet. ___ ___ ___ ___

2. Complete AS1-L2-UVI. Following the procedure developed in item 2 of AS1-L2-UVI and the steps outlined below, reassemble a rear-wheel-drive transmission. ___ ___ ___ ___

   (NOTE: Procedures for repair of transmission components will be discussed in Lesson 2 of this unit.)

   a. Install output shaft.

   b. Install planetary gear sets.

   c. Install input shaft and clutch and drum assemblies.

      (NOTE: Be sure to install the thrust washers in the proper location.)

   d. Install band adjusters, servos, and struts, if applicable.

   e. Install pump bolts and pump.

   f. Check the end play of the input shaft.

      (NOTE: Input shaft end play can be adjusted through the use of thrust washers of various thicknesses.)

   g. Install extension housing and related components.

   h. Using air pressure, test the operation of the hydraulic circuits.

i. Install the valve body.

(NOTE: Be sure to install the ball checks, springs, and linkage in the correct locations.)

j. Install the pan.

Average of above evaluations* ____

(*This average is a partial evaluation for Competency Ff5. Final evaluation for Ff5 will be made at the end of JS2-L2-UVI.)

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

REASSEMBLING A TRANSAXLE

Equipment:

Dial indicator
Selective shims
Selective thrust washers
Inch/lb Torque wrench
Petroleum jelly
RTV-(Optional)
Safety glasses

Evaluation
3 2 1 N

Procedure:

1. Wear safety glasses while doing all procedures on this job sheet. ___ ___ ___ ___

2. Complete AS2-L2-UVI. Following the procedure developed in item 2 of AS2-L2-UVI and the steps listed below, reassemble the final drive of a front-wheel-drive transaxle. ___ ___ ___ ___

   a. Install differential assembly.

   b. Install selected shim to achieve correct clearance.

   c. Install bearing retainers with shim pack and torque to specification.

   d. Measure differential bearing preload and end play. Record measurements.

   e. Install transfer (output) shaft with selective shim.

   f. Measure output shaft preload and end play. Record measurements.

   g. Install differential cover.

3. Following the steps listed below, reassemble the transaxle assembly. ___ ___ ___ ___

   a. Install planetary gear sets and thrusts washers.

   b. Select selective washers and install them.

c. Install planetary gear sets.

d. Install thrust washers.

e. Select selective washer and install.

f. Install bands, clutches, and drums.

g. Install servos, struts, and band adjusting screws.

h. Install pump. Torque to specification.

i. Air test the operation of the clutch packs and bands. Record test results.

j. Check input shaft end play with a dial indicator.

k. Install valve body. Torque to specifications.

l. Install fluid pan. Use a gasket or RTV and torque as recommended.

m. Install governor.

Average of above evaluations* ___ ___ ___ ___

(*This average is a partial evaluation for Competency Ff5. Final evaluation for Ff5 will be made below.)

FINAL EVALUATION INSTRUCTIONS

I. Determine the student's final evaluation for Competency Ff5 by averaging the evaluations of JS6-L1-UV, JS7-L1-UV, JS1-L2-UVI, and JS2-L2-UVI. Use the spaces provided below.

	Evaluation			
	3	2	1	N
JS6-L1-UV	___	___	___	___
JS7-L1-UV	___	___	___	___
JS1-L2-UVI	___	___	___	___
JS2-L2-UVI	___	___	___	___
Final evaluation for Competency Ff5	___	___	___	___

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

AIR TESTING THE OPERATION OF CLUTCH PACKS AND SERVO ASSEMBLIES

Equipment:

Blowgun, regulator and air hose
Automatic transmission fluid
Safety glasses

Procedure:	Evaluation 3 2 1 N
1. Wear safety glasses while doing all procedures on this job sheet.	__ __ __ __
2. Assemble the transmission or transaxle according to procedures in JS1-L2-UVI or JS2-L2-UVI. Following the procedure outlined in item 2 of AS3-L2-UVI and the steps listed below, air test the clutch assembly.	__ __ __ __

(NOTE: The valve body is not installed on the transmission during this test.)

a. Limit air supply to 50 psi.

b. Squirt automatic transmission fluid into the appropriate supply hole.

c. Inject air into the supply hole.

d. Listen for thud and observe the clutches as they apply.

(NOTE: The action of the clutches might not be observable but a tightening of the assembly should occur.)

3. Following the procedure outlined in item 3 of AS3-L2-UVI and the steps listed below, air test the servo assembly.	__ __ __ __

a. Limit air supply to 50 psi.

b. Perform band adjustment according to the manufacturer's procedure.

c. Squirt automatic transmission fluid into apply port.

d. Inject air into the port.

e. Watch for band tightening.

Average of above evaluations* __ __ __ __

(*This average is a partial evaluation for Competency Ff4. Final evaluation for Ff4 will be made at the end of this job sheet.)

FINAL EVALUATION INSTRUCTIONS

I. Determine the student's final evaluation for Competency Ff4 by averaging the evaluations of JS10-L1-UVI and JS3-L2-UVI. Use the spaces provided below.

	Evaluation			
	3	2	1	N
JS10-L1-UVI	___	___	___	___
JS3-L2-UVI	___	___	___	___
Final evaluation for Competency Ff4	___	___	___	___

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

REINSTALLING A REAR-WHEEL-DRIVE TRANSMISSION

Equipment:

Hoist, jack or jack stands
Transmission jack
Safety glasses

Procedure: Evaluation 3 2 1 N

1. Wear safety glasses while doing all procedures on this job sheet. ___ ___ ___ ___

2. Following the procedure outlined below, install the transmission. ___ ___ ___ ___

   a. Support the transmission with a transmission jack.

      (NOTE: The torque converter should be in place on the front pump before the transmission is lifted into the vehicle.)

   b. Raise the transmission into the vehicle.

   c. Position the transmission so that it will clear the engine.

   d. Install bell housing bolts.

      (NOTE: Before the bell housing bolts can be installed, the transmission will generally be held in place by dowel pins. Do not tighten bell housing bolts until all bolts have been started.)

   e Install transmission mount and crossmember.

3. Following the procedure outlined below, replace previously removed components. ___ ___ ___ ___

   a. Install torque converter to the flywheel.

   b. Install appropriate engine, exhaust, starter and any other similar engine components previously removed.

   c. Install bell housing cover.

4. Following the procedure outlined below, replace transmission linkages, cables, and other related items. ___ ___ ___ ___

   a. Replace speedometer cable/wires.

   b. Replace manual shift linkage/cable.

c. Replace wiring connections.

d. Replace cooler lines. Double wrench the lines.

e. Replace throttle, detent valve linkage, and cable.

f. Replace vacuum lines and support clips.

g. Replace any other cables or related items.

5. Complete AS4-L2-UVI. Following the procedure developed in item 2 of AS4-L2-UVI and the steps outlined below, install the drive shaft on the automatic transmission. ____

   a. Unplug output shaft opening.

   b. Remove tape from the rear universal joint.

   c. Align the drive shaft according to the marks made during disassembly.

   d. Install the U-bolts and torque to specifications.

6. Following the procedure outlined below, complete installation procedure. ____

   a. Reconnect the negative battery cable.

   b. Add the proper type and amount of transmission fluid.

      (NOTE: Refer to the proper service manual for procedures on properly filling the transmission after reinstallation.)

7. Check the operation of the newly installed transmission. ____

Average of above evaluations* ____

(*This average is a partial evaluation for Competency Ff1. Final evaluation for Ff1 will be made at the end of JS5-L2-UVI.)

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

REINSTALLING A TRANSAXLE

Equipment:

Hoist, or jack and jack stands
Transaxle jack
Torque wrench
Tape measure
Safety glasses

Procedure:

	Evaluation 3 2 1 N
1. Wear safety glasses while doing all procedures on this job sheet.	__ __ __ __
2. Complete AS5-L2-UVI. Following the procedure developed in item 2 of AS5-L2-UVI and the steps listed below, prepare the transaxle for reinstallation.	__ __ __ __

   a. Place transaxle on suitable jack.

   b. Lift the transaxle.

   c. Install torque converter.

   d. Measure converter depth. Compare to engine flex plate.

3. Complete AS5-L2-UVI. Following the procedure developed in item 2 of AS5-L2-UVI and the steps listed below, reinstall the front-wheel-drive transaxle.	__ __ __ __

   a. Align transaxle to guides.

   b. Install transaxle.

   c. Install bell housing bolts.

   d. Install mounts.

   e. Remove jack.

   f. Inspect half shaft joints and boots.

   g. Install half shafts.

   h. Install engine, exhaust, and suspension related components.

i. Install front wheels. Torque them to specifications.

j. Lower vehicle.

k. Perform transaxle centering procedure, if appropriate.

l. Fill according to manufacturer's procedure.

m. Test transaxle operation. Record test results.

Average of above evaluations* ___ ___ ___ ___

(*This average is a partial evaluation for Competency Ff1. Final evaluation for Ff1 will be made below.)

FINAL EVALUATION INSTRUCTIONS

I. Determine the student's final evaluation for Competency Ff1 by averaging the evaluations of JS1-L1-UVI, JS2-L1-UVI, JS3-L1-UVI, JS4-L1-UVI, JS5-L1-UVI, JS6-L1-UVI, JS4-L2-UVI, and JS5-L2-UVI. Use the spaces provided below.

	Evaluation			
	3	2	1	N
JS1-L1-UVI				
JS2-L1-UVI				
JS3-L1-UVI				
JS4-L1-UVI				
JS5-L1-UVI				
JS6-L1-UVI				
JS4-L2-UVI				
JS5-L2-UVI				
Final evaluation for Competency Ff1				

MODULE: AUTOMATIC TRANSMISSION/TRANSAXLE

UNIT VI: OFF-CAR TRANSMISSION REPAIR

UNIT VI TEST

PART I. REMOVING AUTOMATIC TRANSMISSION/TRANSAXLE

SECTION A. **Read the statements below. Place a T or F in the blank beside each statement to indicate whether it is true or false.**

____ 1. A thrust washer is used to clean the transmission/transaxle prior to removal.

____ 2. Transmission/transaxle jacks are floor or hoist type jacks.

____ 3. The transmission/transaxle should not be drained before removal.

____ 4. Before removing a front-wheel-drive automatic transaxle, the technician must remove the vehicle's front wheels.

____ 5. When removing cooler lines, the technician should always use the double wrench technique.

SECTION B. **Select the best answer from the five choices listed.**

____ 6. When removing the transmission/transaxle, the technician must also remove

a. the starter.
b. the exhaust.
c. speedometer cable.
d. detent cable/linkage.
e. all of the above.

____ 7. When removing the automatic transaxle, the technician does not need to

a. drain the fluid.
b. disconnect the half shafts.
c. support the engine.
d. remove all the motor mounts.
e. install the engine support fixture.

____ 8. The position of the flex plate and torque converter should be marked in order to ensure

a. balance of the unit.
b. drain plug is in the correct position.
c. torque converter mounts align.
d. proper assembly during installation.
e. all of the above.

____ 9. During transmission removal, the negative cable of the battery cable should be removed from the battery in order to avoid all except

a. accidental engagement of the starter.
b. electrical fires.
c. electrocution of the technician.
d. battery explosion.
e. all of the above.

____ 10. After removal, transmission mounts should be

a. marked relative to their location.
b. checked for breakage.
c. replaced.
d. inspected for case alignment.
e. sanded until smooth.

(NOTE: The student must obtain a minimum score of _____ on Part I of the Unit VI Test in order to receive an evaluation for Competency Ff1.)

PART II. SERVICING THE AUTOMATIC TRANSMISSION PUMP

SECTION A. Select the best answer from the five choices listed.

____ 11. Before removing the pump, the technician should measure

a. the torque converter depth.
b. the gear train end play.
c. the starter shaft length.
d. the pump depth.
e. none of the above.

____ 12. To remove the pump, the technician should use

a. a hammer.
b. a slide hammer.
c. a screwdriver.
d. a torque wrench.
e. none of the above.

____ 13. The torque converter hub should be checked for

a. seal scoring.
b. weld cracks.
c. bushing scoring.
d. undercut drive loss.
e. all of the above.

____ 14. To check the transmission pump, the technician should use

a. the pressure gauge and hose.
b. the feeler gauge.
c. the straight gauge.
d. the dial indicator.
e. none of the above.

____ 15. Inspect the flex plate

a. at the pilot area and the gear teeth.
b. at the converter mounting holes and the gear teeth.
c. at the pilot area and the converter holes.
d. from the pilot to the outside of the flex plate.
e. at none of the above locations.

SECTION B. **Read the statements below. Place a T or F in the blank beside each statement to indicate whether it is true or false.**

____ 16. If the flex plate is cracked, the noise will be most noticeable during acceleration.

____ 17. Flushing the torque converter can only be accomplished while the converter is off the vehicle.

____ 18. Some converters have a drain plug so they can be serviced during filter changes.

____ 19. Before the converter is flushed, the one way clutch should always be checked.

____ 20. Oil pump construction usually includes all three basic types of seals/gaskets.

(NOTE: The student must obtain a minimum score of _____ on Part II of the Unit VI Test in order to receive an evaluation for Competency Ff2.)

PART III. INSPECTING AUTOMATIC TRANSMISSION/TRANSAXLE ASSEMBLIES

SECTION A. **Read the statements below. Place a T or F in the blank beside each statement to indicate whether it is true or false..**

____ 21. Planet bearings are checked during the gear train inspection.

____ 22. Bushing inspection is not performed until after all other components are repaired.

____ 23. During the gear train inspection, the park pawl is inspected.

____ 24. The shaft oil delivery system is checked by forcing oil through the shaft.

____ 25. Selective thrust washers are only checked for thickness.

SECTION B. **Select the best answer from the five choices listed.**

____ 26. Shaft inspection does not include inspection of

a. worn bearing surfaces.
b. scored bearing surfaces.
c. worn splined teeth.
d. rounded snap retainer grooves.
e. internal gear teeth.

____ 27. Shaft sealing rings should not be checked for

a. side clearance.
b. worn sealing surfaces.
c. cracked separation lands.
d. end clearance.
e. thrust washer thickness.

____ 28. The park pawl should be inspected for

a. rounded teeth.
b. worn pivot shaft.
c. weak return spring.
d. loose or bent penitent shaft.
e. all of the above.

____ 29. To check bushings, the technician should use

a. a dial indicator.
b. a feeler gauge.
c. a concentric gauge.
d. a snap expander.
e. all of the above.

____ 30. The hub on the park pawl is connected to the

a. input shaft.
b. output shaft.
c. planetary gear set.
d. rear servo.
e. valve body.

(NOTE: The student must obtain a minimum score of _____ on Part III of the Unit VI Test in order to receive an evaluation for Competency Ff3.)

PART IV. CLEANING AND INSPECTING FRICTION AND UNITS

SECTION A. Select the best answer from the five choices listed.

____ 31. The purpose of a wavy disc in a clutch pack is to

a. cushion the application.
b. slow the application.
c. increase the holding area.
d. prevent fluid leakage.
e. lower seal wear.

____ 32. Clutch pistons should be inspected for

a. size.
b. runout (out of round).
c. taper.
d. seal direction.
e. none of the above.

____ 33. Clutches are checked for all the below problems except

a. warping.
b. cracking.
c. missing spline teeth.
d. thickness.
e. missing clutch material.

____ 34. If the piton seal is installed incorrectly,

a. the clutch will not release.
b. the transmission will not shift.
c. the clutches will be destroyed.
d. the clutch hub will freeze.
e. all of the above will occur.

SECTION B. **Read the statements below. Place a T or F in the blank beside each statement to indicate whether it is true or false.**

____ 35. Clutch hubs should be deglazed with crocus cloth.

____ 36. Clutches have internal splines.

____ 37. One-way clutches cannot be installed to lock in the wrong direction.

____ 38. If a band is smooth (no grooves), it is probably worn out.

____ 39. Air tests are used to check the operation of clutches and bands prior to assembly.

____ 40. Band struts are sized to compensate for band wear.

____ 41. A sprag clutch is a type of one-way clutch.

(NOTE: The student must obtain a minimum score of _____ on Part IV of the Unit VI Test in order to receive an evaluation for Competency Ff4.)

PART V. REASSEMBLING THE AUTOMATIC TRANSMISSION/TRANSAXLE

SECTION A. **Read the statements below. Place a T or F in the blank beside each statement to indicate whether it is true or false.**

____ 42. The input shaft is generally the first part installed during transmission/transaxle assembly.

____ 43. RTV is used to hold washers in place during transmission/transaxle assembly.

____ 44. The valve body must be torqued in place.

____ 45. When installing the torque converter, the technician must make sure that the converter is fully seated.

____ 46. All transmissions use dowel pins to hold the transmission/transaxle in place.

SECTION B. Select the best answer from the five choices listed.

____ 47. Before installing the transaxle, the technician should

a. inspect the front-wheel bearings.
b. check front suspension components.
c. check the C.V. joints.
d. check the cooler for leaks.
e. do all of the above.

____ 48. Selective thrust washers are used to

a. increase the wear life of components.
b. hold components together.
c. reduce wear in the transmission.
d. adjust end play clearance.
e. do none of the above.

____ 49. When installing the transmission/transaxle, the technician should

a. install all housing bolts before completely tightening them.
b. tighten the first housing bolt to pull up the transmission.
c. start and tighten two housing bolts opposite of each other before installing all bolts.
d. use the transmission jack to force the transmission up to the engine.
e. do none of the above.

____ 50. The final step in rebuilding an automatic transmission/transaxle is to check for

a. leaks.
b. proper operation of the unit.
c. proper engine performance.
d. proper fluid level.
e. none of the above.

(NOTE: The student must obtain a minimum score of _____ on Part V of the Unit VI Test in order to receive an evaluation for Competency Ff5.)

ANSWERS TO UNIT VI TEST

1.	f
2.	t
3.	f
4.	t
5.	t
6.	e
7.	d
8.	d
9.	c
10.	b
11.	b
12.	b
13.	e
14.	b
15.	b
16.	f
17.	t
18.	t
19.	t
20.	t
21.	f
22.	f
23.	t
24.	f
25.	f
26.	e
27.	e
28.	e
29.	b
30.	b
31.	a
32.	d
33.	d
34.	e
35.	t
36.	t
37.	f
38.	f
39.	t
40.	f
41.	t
42.	f
43.	f
44.	t
45.	t
46.	f
47.	e
48.	d
49.	a
50.	b